DICTIONARY OF PRACTICAL SURGERY

HEATH

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DICTIONARY

OF

PRACTICAL SURGERY

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DICTIONARY
OF
PRACTICAL SURGERY

BY

VARIOUS BRITISH HOSPITAL SURGEONS

EDITED BY

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PREFACE

The Dictionary of Practical Surgery will, it is hoped, supply a want in the library of the busy practitioner, who necessarily often meets with cases of surgical disease or injury on which he desires to have immediate information as to diagnosis and treatment. With the view of assisting him, as far as is possible for a book to do so, in arriving at a correct diagnosis (on which suitable treatment must of course depend), a series of articles on the diagnosis of the injuries and diseases of the several regions of the body has been introduced, as well as general articles on Deafness, the Eye, Skin Diseases, &c. The surgical affections will be found fully described under their proper names, in alphabetical order; or when it has been found more convenient to group together a series of diseases of one organ—as, *e.g.*, of the Breast—cross-references have been given, the name of the separate article referred to being printed in small capitals.

The subjects are treated of, so far as is practicable, in the following order:—1, Cause; 2, Pathology; 3, Symptoms and Diagnosis; 4, Treatment; 5, Prognosis. Each writer has signed his articles, and is responsible for the statements contained in them; but the Editor has, of course, exercised a general supervision, and has endeavoured to prevent the promulgation of crude theories, or the inculcation of doubtful practices. At the same time, he has not attempted to reconcile the views of surgeons who may happen to differ on points of practice; nor does he endorse every statement put forth by the various writers. It was impossible to illustrate the Dictionary, both on account of the extra space which would have been occupied, and also on account of the time necessary for the production of original woodcuts. The aim of the Editor has been to produce a compendium of the practice of British Surgery of the present day, and, as only two years will have elapsed between the first planning of the Dictionary and its publication, that object will have been fairly attained.

At the end of the second volume will be found a General Index of Subjects, which will, it is hoped, greatly facilitate reference to the several articles bearing on any special subject, and also an Index of Authors, giving the contributions of each. The Editor has to thank these gentlemen for their valuable contributions and for the promptitude with which they have completed their labours.

The Editor has also to offer his best thanks to Mr. W. JOHNSON SMITH, who has acted as Sub-editor of the whole work; and to Dr. ROBERT LIVEING and Mr. JOHN TWEEDY, who have respectively supervised the articles on Diseases of the Skin and Affections of the Eye, for their valuable co-operation.

CAVENDISH SQUARE: *January* 1886.

DICTIONARY
OF
PRACTICAL SURGERY

ABDOMEN, Injuries of the.—All abdominal injuries are attended by more or less shock; if this be of a persistent or relapsing nature, grave internal mischief is denoted, although authenticated cases are on record in which a blow on the epigastric region has resulted in death, due solely to shock. Continuous pain, which becomes most intense at one point, and radiates over the abdomen from this, is an unfavourable sign. Persistent vomiting should be regarded as a symptom pointing to visceral injury. In all cases the abdomen must be very carefully examined, and it is specially desirable to ascertain if the bladder be intact. Purgative medicine should always be avoided until the exact injury has been diagnosed.

CONTUSION OF THE ABDOMINAL PARIETES. This injury occurs both without and with rupture of some abdominal textures and underlying viscera.

Simple contusions may be either cutaneous or musculo-cutaneous.

The *cutaneous* ones are caused by slight blows, falls, kicks, or wheels of heavy vehicles.

The *symptoms* depend on the extent of the injury. Generally there will exist feelings of faintness and sickness, anxious face, and diminution in the warmth of the extremities; pain in the region of the injury, increased by movement; more or less pain during respiration, followed by ecchymosis of the skin over the affected area.

Treatment.—Rest in the horizontal position. Stimulants in small doses to counteract the shock; anodynes to relieve pain. Locally, warm poultices or ice. If blood has been extravasated in small quantity it is apt to give a peculiar crepitant feeling to the hand of the surgeon, if in large quantity it may be necessary to aspirate the fluid portion.

CONTUSION WITH MUSCULAR RUPTURE. This may exist as a small tear of one muscle, most frequently the rectus, or the whole thickness of the muscular wall of the abdomen may be rent.

Causes.—Passage of wheels over the surface of the abdomen, and buffer-accidents.

Symptoms.—Those of shock; some pain in affected region, increased by movement: if the patient be seen directly after the receipt of the injury, separation of the muscular fibres may be detected; but this is often difficult to discern, as the lesion is quickly followed by extravasation of blood and tumefaction. If the whole thickness of the muscular wall of the abdomen is involved, the symptoms will be more marked, and even resemble those of internal hæmorrhage, viz. pale and anxious face, extreme prostration, general restlessness, pulse small and feeble, skin cold and clammy.

Prognosis.—This depends upon the degree of rupture. If the whole muscular wall be torn, death may take place from shock. If recovery ensues, the formation of a ventral hernia must be looked for.

Treatment.—Rest in the horizonal position. Stimulants at first in small doses. Locally, hot fomentations, ice, or Leiter's coil; opium, or some of its preparations, by the mouth, rectum, or subcutaneously to relieve pain. The abdomen should be supported by a flannel bandage, a suitable belt, or by strapping if the rupture be small. Any intestinal protrusion must be returned, and a firm dry compress applied over it. Should symptoms of strangulation ensue, the opening must be exposed by incision, the bowel returned, all blood-clot removed, and the parietal wound closed by silk sutures.

RUPTURE OF THE STOMACH WITHOUT EXTERNAL WOUND.—*Causes.*—Direct violence applied to the epigastric region.

Symptoms. — Marked collapse, pallid skin, clammy sweats, pulse small and weak, tenderness over the whole abdomen, most marked in the epigastric region; vomiting of blood and matter resembling coffee-grounds may or may not be present.

Prognosis.—Unfavourable: death always taking place within twelve hours of the receipt of the injury.

Situation.—Any portion of the stomach may be affected, but in the cases recorded the majority were ruptured near the pyloric extremity, and on the great curvature. All the coats of the viscus may be torn, or the mucous and peritoneal may suffer, and the muscular be left intact.

Treatment.—Rest in bed, warmth, ether subcutaneously for shock, and morphia administered in the same manner to allay pain. Stimulant and nutrient peptonised enemata should be given, and nothing by the mouth.

RUPTURE OF THE INTESTINE FROM EXTERNAL VIOLENCE WITHOUT WOUND OF THE PARIETES.—*Causes.*—Force applied suddenly to the front and sides of the abdomen, such as that caused by the wheels of a vehicle, blows or kicks of a man or animal.

Symptoms.—Those of shock: the face pale and anxious-looking; restlessness; tympanites following almost immediately the receipt of the injury. The pain in the abdomen is great, and rapidly diffuses itself all over the belly. As peritonitis is developed, the muscles of the abdominal wall become tense and unyielding. Vomiting is constant and distressing, and usually commences immediately after the injury has been inflicted. Any food in the stomach is first ejected, then grumous-looking fluid, finally stercoraceous matter. The tongue varies, being generally dry, coated and red at the edges. Intense thirst is present. The respiration is thoracic, rapid and shallow. The pulse varies—at first feeble and somewhat slow, then rapid and thready.

Parts affected.—Any portion of the intestinal tract, from the stomach to the rectum, may be injured; but the small intestines, jejunum and ileum, are most frequently lacerated. The size of the wound varies greatly.

Prognosis. — Unfavourable, as death generally ensues in forty-eight hours, the later symptoms being those of extreme prostration. A chronic circumscribed peritonitis may result, ending in absorption or abscess, and recovery. Such cases, however, are the exception, and not the rule.

Treatment.—Rest in bed, and the application of artificial heat to the extremities. Morphia should be administered subcutaneously every two hours, if needed, until the acuteness of the pain is lulled. Anodyne suppositories may also be used, but are not so efficacious in relieving the pain. For the intense thirst, ice may be given to suck, or iced water in teaspoonful doses. If this be ejected by the stomach, warm water in the same quantities may be tried.

Locally. — Hot fomentations, or light linseed poultices, alone or with laudanum, may be applied. A cradle should be employed to keep off the weight of the bed-clothes.

When the diagnosis has been made as certain as possible, and the symptoms are hourly becoming more urgent, some surgeons might feel justified in opening the abdomen to seek the injured intestine. *See* LAPAROTOMY.

EMPHYSEMA OF THE ABDOMINAL WALL. This condition, as the result of injury, is a sign of rupture of the underlying intestine, and an escape of flatus into the sub-peritoneal tissues. A puffy, doughy, crepitant swelling, usually commencing in the flank, slowly creeps up the abdominal wall, which may even become resonant on percussion. The air is generally re-absorbed without requiring any puncture.

WOUNDS OF THE ABDOMINAL WALLS.—The various kinds of wounds of the walls of the abdomen may be: 1. incised; 2. punctured; 3. lacerated and contused.

1. *Incised wounds* are produced by sharp cutting instruments, glass, and china, and may extend to any depth, down to the peritoneum. When the direction of the wound is transverse, the consequent gaping is apt to be more marked than when the direction is vertical. Unless some branch of the internal mammary or epigastric arteries is severed, the hæmorrhage caused is not great, but there is most risk of bleeding when the injury is in the iliac region.

2. *Punctured wounds* are of a more dangerous nature, as their exact extent is not always evident, and probing and other manipulations should be avoided, or at any rate but very gently employed. Suppuration is apt to follow the infliction of this type of wound, which, spreading in the cellular planes between the muscles, may ultimately set up peritonitis.

3. *Lacerated and Contused Wounds.*—These, clinically, may be classified together; they are caused by blunt instruments, the horns and teeth of animals, and firearms. The injured textures are prone to slough, and the severity of the symptoms will depend upon the depth of the injury. Gunshot wounds, which are the result of spent balls, generally suppurate extensively; healing takes place slowly.

Treatment.—The immediate treatment of all varieties of wounds of the walls of the abdomen consists in the cleansing of the wound and the staunching of the hæmorrhage. The former should be accomplished with clean warm water, or an antiseptic solution, such as carbolic acid (1 to 40) or corrosive sublimate (1 to 1,000). If the bleeding be only slight, it may be controlled by a pad of lint or a piece of sponge; if more profuse, and a spurting artery is visible, the vessel divided must be secured, either with a catgut ligature or by torsion. Should the precise bleeding point be obscured, the wound must be cautiously enlarged until it can be brought into view, and then secured.

If the wound be an incised one, the edges should be approximated by sutures passing deeply through all the divided tissues, and a suitable drainage-tube be inserted at the lower angle of the wound. In punctured and the other variety of wounds of the abdominal parietes, no attempt at closure should be made.

The subsequent dressing may be Listerian, or of lint steeped in carbolic or terebene oil (1 in 10), boracic glycerine (1 in 4), or an aqueous solution of carbolic or boracic acid, or corrosive sublimate (1 in 2,000); and either wood-wool pads or those composed of an antiseptic absorbent cotton-wool should be placed over and secured by a broad bandage firmly applied, to counteract the tendency to ventral hernia. As far as possible, perfect rest should be enjoined, and all tension taken off the abdominal muscles by bending the trunk in a forward direction.

Wounds of the Abdomen with Protrusion of Uninjured Viscera. — The escape of the contents of the abdominal cavity is relatively much greater than the size of the wound, and a larger protrusion results from incised and lacerated wounds than from punctured ones. Omentum, intestines, stomach, bladder, and liver may all protrude, but the omentum and small intestines do so most frequently.

Prognosis.—In all cases of wounds of the abdomen with visceral protrusion, the outlook is serious, as the consequent shock is severe, and peritonitis and septicæmia are very frequent complications, causing a fatal termination.

Treatment.—Before entering into details of the treatment of the various viscera when projecting through an opening in the abdominal walls, a few preliminary points with reference to the treatment of all injuries of the abdomen should be stated. A very important matter to be attended to is, as far as possible to enjoin absolute rest for the viscera; for this purpose, but little nourishment should be given for the first three days except in the form of a little milk and water. Pain should be allayed by morphia given subcutaneously or by suppository. Efforts at coughing, straining, or vomiting, should be avoided; if the last-named symptom be present, the patient should be fed by pancreatised enemata, and nothing but small quantities of warm water given by the mouth.

Locally.—All hæmorrhage should be stopped, and care taken that at the first dressing the peritoneum be left clean and dry. No irritating antiseptic should be applied to the peritoneum, or this end may be defeated. Especial care should be taken that all sponges and fingers are aseptic and are used warm. The protruding viscera should be handled as little as possible, and while exposed should be covered with a flat warm sponge.

Protrusion of the Omentum.—A careful examination must be made as soon after the injury as possible, to see that no coil of the intestines is concealed. This having been demonstrated, the exact-treatment will depend upon the existing condition of the hernia. The injury being recent and the omentum sound and reducible, the protruding mass is to be cleaned with an aseptic sponge and warm water and returned gently into the abdomen. The wound is to be closed with an interrupted or continuous suture, including the entire thickness of the abdominal wall.

Should the omentum be irreducible, congested or strangulated, it must be left in position, plugging the wound. A compress of antiseptic gauze, absorbent wool, wood wool, or lint soaked in boracic glycerine, terebene oil, or warm water, should be applied and kept in position by means of a broad bandage. If no urgent symptoms supervene, the dressings should be left *in situ* for several days, and when adhesions have been formed, a double ligature should be passed through the protruding fatty mass, just above the level of the skin, and it should be firmly tied in two halves. The portion of omentum projecting above the ligature should be gently removed with the knife or scissors. That part left plugging the wound will subsequently granulate, and the opening close.

If, when first seen by the surgeon, the omentum be inflamed, adherent, suppurating, or gangrenous, the mass should be ligatured and removed at once.

PROTRUSION OF INTESTINE.—The protrusion being recent, an anæsthetic should be at once given, and the projecting coil protected by a sponge wrung out in hot water. The gut having been gently and carefully cleaned, it should be returned into the abdominal cavity by means of the thumb and forefinger of one hand and the pressure of the warm sponge with the other. The intestine should be followed into the peritoneal cavity, in order that perfect reduction may be effected, and that it may not be merely pressed back between the peritoneum and the abdominal wall.

Reduction having been accomplished, a piece of warm flat sponge should be passed in at the opening, and left overlying the returned gut, until the closure of the external wound is all but completed: it should then be withdrawn. The silk sutures for closing the abdomen may be either interrupted or continuous, and should include the peritoneum and all textures composing the abdominal wall. Some surgeons prefer to close the peritoneum first, by means of a continuous catgut suture, and afterwards the wound in the parietes. Pads of dry lint, cotton wool, or wood wool should then be applied, and maintained in position by strapping and a broad flannel bandage.

Should, however, the protruding mass of intestine be large and irreducible through the original wound, either this must be sufficiently enlarged in an upward or downward direction, the surgeon's forefinger being introduced into the abdominal cavity to act as a guide, until the necessary reduction can be accomplished; or the protruding coil may be aspirated or punctured with a small needle, and emptied of its distending flatus. Reduction in a collapsed state may then be attempted.

If the protruded mass be already inflamed or deeply congested, it should still be returned into the abdomen, but the external opening must not be quite closed at its lower angle, to allow of the insertion of a glass drainage-tube for at least twenty-four hours. Should the intestine be strangulated and gangrenous, or very doubtful-looking, the opening in the abdominal walls should be enlarged to relieve the constriction, and no attempt should be made at reduction, but the affected coil be left *in situ* and watched. In such cases, the formation of an artificial anus offers the most hopeful prognosis. If the jejunum be the injured part, and a false anus supervenes, death will eventually take place from inanition. The gangrenous mass may either be incised or left to slough. The dressing should be warm charcoal and linseed poultices, or antiseptics such as boracic acid, carbolic and terebene oils, and iodoform in powder.

WOUNDS OF HOLLOW VISCERA.—These are very grave injuries, and the prognosis is unfavourable on account of the extreme shock which is occasioned, the extravasation of the contents of the intestine, and the subsequent peritonitis. The hollow viscera may be injured by incised, punctured, lacerated, or gunshot wounds, and the coiling of the intestines renders them liable to be the seat of multiple wounds. The relative frequency of the seat of injury is as follows:—1. Small intestine. 2. Transverse colon. 3. Stomach. 4. Ascending and descending colon.

Wounds of the intestines may occur (1) with or (2) without protrusion, and the extent of the injury will vary from a mere prick or wound a few lines long, to complete severance of the tube. When a mere puncture occurs, the mucous coat will often prolapse, and plug the wound in the muscular and peritoneal coats. When the small intestine is the portion of the tube injured, the prognosis is more unfavourable than when the colon is so affected, owing to its contents being more liquid, the covering of the peritoneum more complete, and the tube less fixed in position.

Symptoms.—Severe and prolonged collapse, pale and anxious countenance, feeble quick pulse, cold and clammy extremities, vomiting, thirst, great local pain, and the escape of flatus and fæces through the wound. Peritonitis speedily sets in.

Treatment.—The first step in all varieties of wounds of the hollow viscera is to stop hæmorrhage, and to ensure rest in the horizontal position. Morphia or opium should be administered for the pain, and all solid nourishment should be abstained from for three days, the patient merely sucking ice, or taking teaspoonfuls of warm or cold water at intervals. If possible, the bowels should be confined for ten days. If the large gut be intact, pancreatised enemata may be administered for purposes of nourishment.

Wound with Protrusion.—When the wound is a mere prick, the peritoneal cavity should be carefully sponged out, the bowel returned, and the wound closed.

If the wound be a few lines long, the intestinal tube should be held on each side of the opening with forceps, and a catgut ligature applied. The intestine should then be returned into the abdomen, and the wound closed. The wound being large, and the coats of the intestine cleanly incised, a continuous carbolised or catgut suture should be applied, as far as possible avoiding the mucous coat, and replacement effected, with closure of the wound.

Should the wound of the gut be lacerated, the intestine should be sewn to the skin of the parietal wound, and an artificial anus constituted. When the intestine is cut right across, an endeavour may be made to close the wound by a continuous silk ligature, applied with great care, to bring similar textures into apposition, or an artificial anus may be made. In our present state of knowledge, the latter procedure seems to offer the best prognosis.

Without Protrusion.—The wound in the wall of the abdomen must be carefully enlarged, and the opening in the viscera looked for. If found, it must be treated according to its dimensions. (*See* above.) Should the wound not be discovered, the peritoneal cavity must be thoroughly washed out, and a large glass drainage-tube passed down into the pelvis, the parietal opening being closed, except at the lower end. THOMAS F. CHAVASSE.

ABDOMINAL ANEURISM. — The abdominal aorta is subject to degenerative changes which rob the vessel of its elasticity, and render it liable to rupture of its coats and the formation of a false aneurism; or the elastic coat may alone be at fault, and a permanent dilatation of all the coats of the vessel may result, constituting a true aneurism in the affected part of the vessel. The existence of true aneurism of the abdominal aorta is, however, a very rare occurrence.

In this vessel another factor comes into play in producing aneurism, viz. sudden or violent exertion of the trunk of the body. This often leads to the formation of an aneurism in a tolerably healthy vessel, a fact of importance in considering the treatment of the disease, as it is in these cases, resulting from violent straining of the vessel, that we may look for the best results in adopting treatment by pressure.

Most of the aneurisms in this vessel are sacculated (60 per cent.), and vary in size, from the smallest pouch-like depression, to sacs of a size as large as the vessel and the surrounding parts will permit. In these large aneurisms the internal and middle coats of the vessel almost disappear, or exist as mere calcareous or atheromatous patches, while the external coat is often much increased in thickness, and supported by adherent organs. On the other hand, the external coat may become attenuated by the pressure of surrounding parts. Thus, either absorption of the coats of the vessel, and erosion of the surrounding parts, or adhesion and thickening of its walls, may be going on in an aneurism; and its duration will be largely determined by the prevalence of the one or the other of these processes. The sac of the aneurism may be almost filled by coagula of blood and fibrin, or it may be almost empty. This difference, to a large extent, depends on the size of the orifice of communication between the sac and the vessel, by which the volume of the current of blood in the sac is regulated. This is a matter of some importance in enabling us to form an opinion of the treatment to be used. A globular aneurism, forming a distinct and somewhat movable tumour, is likely to have a small orifice, and is favourable for the deposition of blood-clot or fibrin; and in it the current can be most effectually cut off by pressure when an aneurism enlarges.

While in most cases aneurisms of the abdominal aorta tend to increase in size, and eventually to burst, there are not a few cases on record in which spontaneous cure has occurred. Hodgson related the case of a small aneurism which had hollowed out the body of a vertebra by pressure, and had then become completely filled up by the layers of fibrin. Again, a sacculated aneurism has been found doubled over on its aperture of communication with the aorta, and thus cured by its own pressure. Holmes quotes a case of spontaneous cure of an aneurism of the cœliac axis, which he discovered in the body of a man who had never complained of any symptoms of aneurism. The sac was obliterated, except a channel in the centre filled with soft clot, through which the circulation must have been maintained in the large branches of the cœliac axis. He refers, also, to the curious preparation in the Hunterian Museum of the abdominal aorta of a jaguar with an aneurism nearly consolidated.

Seat of the Disease.—The disease may occur at any point in the circumference of the vessel, and the late Dr. Sibson has shown that it springs just as often from the front of the vessel as from its posterior aspect. It may be as high as the pillars of the diaphragm, or it may occupy the origin of the cœliac axis, or, more frequently, it lies on a level with, or below, the renal arteries. It occurs less frequently in the lower third of the vessel, generally involving the inferior mesenteric artery, if the sac is large. The arteries involved in the aneurismal pouch are either dilated or obliterated, the former by the expansion of the walls of the vessel, the latter by pressure of the tumour as the vessel passes over it, or by plugging with fibrin from within. Pressure on the surrounding organs often results as the aneurism enlarges, leading to jaundice, from pressure on the liver or bile-ducts, or to nausea from pressure on the stomach and duodenum; or to dysphagia from pressure on the œsophagus, or to uræmia, in rare cases, from pressure on the kidneys or renal vessels. Sometimes organs are pushed out of their natural position by abdominal aneurisms, e.g. the liver may be pushed forward, or the left kidney pushed to the opposite side.

The vena cava is seldom compressed, and on this account dropsy of the extremities and enlargement of the superficial veins are rare in abdominal aneurism. The colon may be compressed, so as to lead to obstruction of the bowels.

An aneurism which springs from the front of the aorta presses on the ganglia and plexuses of the sympathetic system, leading to pain in the epigastric region, for the most part. An aneurism which springs from the posterior aspect of the aorta presses on the spinal nerves, leading to pain (chiefly paroxysmal and radiating) in the back and loins. These posterior aneurisms produce erosion of the vertebræ, but statistics show that the characteristic pain may be present without erosion, and erosion without the characteristic pain, so that no relation exists between pain and erosion. The pains doubtless arise from pressure on the spinal nerves.

Abdominal aneurisms are liable to rupture; and the formation of a diffuse aneurism, when bleeding occurs into the areolar tissue, is the result. Rupture may also occur on the surface of the skin or mucous membrane, or into the peritoneal cavity.

The Causation of the Disease.—The predisposing cause is degeneration of the coats of the vessel. The chief exciting cause is strain produced by over-exertion. Advanced age, syphilis, intemperance, and all other influences which impair the constitution, lead to these degenerative changes of the tissues which favour aneurism. In the writer's opinion, syphilis is most often the principal factor in this disease. The occupations which seem to predispose to the disease are all of a laborious nature—smiths, strikers, excavators, navvies, porters, paviours, being its victims. Where the disease occurs apart from great bodily exertion, we may infer the existence of considerable degeneration of the vessel.

Symptoms.—Pain is the earliest and most prominent symptom—sometimes continuous, with occasional paroxysms of increased severity; at other times, almost entirely paroxysmal or intermittent. It occurs in the epigastrium or hypogastrium, and in the back or loins; in the former cases it indicates aneurism of the front of the aorta, in the latter it indicates a posterior aneurism. The pain radiates around the trunk, down the extremities, and into the testicle. It varies in character, as indicated by the words turning, catching, twisting, lancinating, or boring. Often a dull pain when continuous, it becomes sharp and severe when paroxysmal. A pulsating tumour is also a very prominent symptom. The pulsation is generally felt equally in all directions, and the tumour is felt to expand under the hand with each pulsation of the aorta. A double shock is sometimes felt when the tumour is so near the heart as to receive an impulse from it.

The tumour is generally fixed, its non-mobility with the diaphragm being highly characteristic. The pulsation may be felt in the epigastrium, a little to the left of the middle line, or it may be covered by the margins of the left ribs. More rarely it inclines to the right, pushing forward the liver with each impulse. It sometimes lies so deeply in this region as to be barely perceptible on deep pressure.

The *diagnosis* in these cases is rendered extremely difficult, especially when we remember how vividly a nervous pulsation of the aorta will simulate an aneurism. In the latter case, we have an aneurism with scarcely perceptible pulsation, and in the former we have violent pulsation of the aorta without an aneurism. The tumour may appear in the loin or in the groin, and may simulate a lumbar abscess in the one case, or a psoas abscess in the other. It may also be mistaken for disease of the spleen and kidney. Let it be specially noted that an aneurism may exist where no tumour at all can be felt.

The pulsating tumour may vary in size, shape, and consistency to almost any extent, so that no valuable indication can be derived from these points, but it possesses a special characteristic in the *bellows-murmur*, which occurs in a large number of cases. If this murmur be systolic in time, and be distinct from any cardiac murmur which may exist, it becomes a very reliable sign of the disease. In all doubtful cases the stethoscope should be applied to the left vertebral groove, as well as in front, since a murmur audible in the back is strong evidence of the disease.

Dyspnœa from pressure on the diaphragm, cough from the same cause, dysphagia from pressure on the œsophagus, nausea, spasmodic flatulent pain and constipation from pressure, are secondary symptoms; as also are numbness or coldness of the legs, formication, pricking pain and loss of power in the lower extremities. On the other hand, ascites and anasarca are exceedingly rare in this disease. It must not be forgotten that all these symptoms may subside for a time, and apparent recovery may take place, until sudden death reveals the secret existence of the disease. In most cases, if not cured by treatment, the patient passes through a period of increasing pain, restlessness, insomnia, emaciation and exhaustion, until rupture puts an end to his sufferings.

Let it be noted that the following symptoms are rare in aneurism, and contraindicate the presence of the disease:—Rapidity of pulse, œdema of the lower extremities, ascites, enlargement of the superficial abdominal veins; the presence of pus, mucus, blood, or albumen in the urine, jaundice, mobility of tumour without murmur, the malignant cachexia of cancer, and the deposits of cancer or tubercle.

The duration of the disease varies from a few months to many years. After the first appearance of prominent symptoms, the patient rarely lives more than eighteen months, and generally dies within three months, unless he is rescued by surgical or medical treatment.

Death may occur from exhaustion, pressure on vital parts, or hæmorrhage. The hæmorrhage may be suddenly fatal, or it may let life ebb out in a gentle stream, and the patient may get relief of all his symptoms before he dies. When the bleeding occurs into the peritoneum death is sudden, and when into the stomach, lungs, or bowels, blood will often be discharged from these cavities before death. The occurrence of bleeding is often followed by the formation of a soft, semi-fluctuating tumour in one of the abdominal regions, indicating the formation of a diffuse aneurism.

Treatment.—The treatment of abdominal aneurisms has come within the range of practical surgery during the last twenty years. Previously, these diseases were regarded as beyond the pale of surgical treatment, and the efforts to cure them consisted mainly in a system of resting the parts; while the circulation of blood was reduced by medicines and diet to a level which was supposed to be conducive to the formation of layers of fibrin, by which the aneurismal sac might be filled up.

Since the year 1864 a considerable number of cases have been cured by the application of the rapid-pressure treatment—i.e. by applying pressure to the aorta, above the seat of the aneurism, so as to stop the circulation of blood in the vessel. This method of rapid and complete pressure in the case of aneurisms of the abdominal cavity has established the following points:—

1. That aneurisms of the abdominal aorta (or its branches) are curable by pressure.

2. That pressure is not necessarily a long process, as had been previously supposed, but when efficiently applied its action may be *rapid*—so rapid as to reduce its application from *many hours* to *as many minutes* in some cases.

3. That occlusion of the aorta may occur suddenly, without much risk to the patient, and that a very rapid opening up of new channels by the anastomoses of vessels is the means by which circulation is re-established in the lower parts of the body.

4. That the administration of chloroform is necessary in the application of this rapid method, inasmuch, as, without it, currents of blood are liable to pass through the sac of the aneurism, and disturb the coagulation going on there.

5. It is probable, from the rapidity with which the cure of a large aneurism may take place, that the process depends on coagulation of blood to a large extent, and not on the deposition of layers of fibrin only.

Before adopting any surgical measure for the cure of aneurism of the abdominal aorta, it is advisable to try the effect of absolute rest in the recumbent position for two or three weeks, and during this period of rest the treatment by iodide of potassium in large doses should also be adopted. The success attending Tuffnell's treatment by diet and rest alone would justify this preliminary process, and the still greater success following the use of large doses (30 grains three times daily) of iodide of potassium, gives this treatment a fair prospect of success.

Should the trial of rest, spare diet, and iodide of potassium have produced no change for the better, either in the disease or in the condition of the patient, we are justified in resorting to the use of pressure.

Two things are now to be considered:

1. The state of the patient as to general health, as to the state of the heart and arteries, and as to the state of the kidneys.
2. The site and anatomical relations of the aneurism.

First, as to the general condition of the patient, it is most essential to examine the important viscera, and the existence of organic disease of any of them is to be regarded as an obstacle to the success of the pressure treatment. Cachexia, either general or specific, also negatives the hope of success. Secondary and tertiary syphilis may yield to the iodide of potassium, which should be fully tried in such cases. The cachexia of cancer is of course decisive. Ordinary anæmia is unfavourable. Ascites renders pressure impossible, and œdema of any kind should be traced to its source. Should it indicate renal disease, with the slightest trace of albumen, blood, or casts in the urine, the pressure treatment is thereby contra-indicated. In all cases the urine should be carefully and repeatedly examined for albumen and sugar. Above all it is necessary to determine the state of the arterial system. Extensive degeneration, heart-disease, the existence of another aneurism in the chest or elsewhere, all contra-indicate a favourable result. Should there be an absence of these unfavourable conditions, the next step will be to inquire if the site of the aneurism permits of pressure being applied.

In considering the question of site in relation to the application of pressure, two methods may be pursued :—1. The ready method of trying the application of a tourniquet under chloroform, to ascertain if there is space enough above the aneurism to permit of the vessel being fully compressed by the instrument. 2. It will be found that pressure can rarely, if ever, be brought to bear on the vessel above the renal arteries.

If, however, in a very tall patient with a short chest and a wide epigastrium, pressure were contemplated, it would be unwise to venture on it without duly considering the site of the renal arteries in such a subject. In ordinary subjects there is no need to insist on the rule, 'that pressure should never be applied on or above the renals,' as this is simply impossible. So that we may safely say that we may press as high up as we can apply the pad of the tourniquet. In most cases this point will be found to coincide with the left triangle of the epigastrium. Although aneurisms above the renal arteries are never cured or treated by *proximal* pressure, they admit of treatment by *distal* pressure. Mr. Bryant's case shows that curative changes do occur in the aneurism, even as high as the cœliac axis, when subjected to distal pressure. Where other conditions are favourable we should continuously try distal pressure when other means fail to relieve the patient.

Below the origin of the renal arteries there is nothing to prevent the use of pressure. It is here both a practicable and tolerably safe procedure.

Let us now proceed to state what is to be done in a case where the trial of the rapid-pressure treatment for abdominal aneurism has been decided on. The patient needs to have the abdominal viscera unloaded, as far as possible, by a gentle aperient which removes flatus while acting. One aloe and assafœtida pill, followed by magnesia and rhubarb with ginger and other carminatives, will probably do this. If necessary an enema of assafœtida and turpentine may be given. The bladder is to be emptied. Nothing of a solid nature is to be eaten for three or four hours before the operation. The next step is to administer chloroform, and to put the patient fully under its influence before attempting pressure. Sometimes a preliminary administration of chloroform may be tried, to see how far and how easily the pressure may be applied without injury to the patient. As the patient may become exhausted by the long-continued anæsthesia, the administration of strong peptonised beef-tea enemata, during the operation, is necessary, and in some cases brandy in the enemata is needed.

The tourniquet may be that of Lister, or Carte, or the ordinary horse-shoe tourniquet may suffice. In the hands of an experienced surgeon the horse-shoe tourniquet is best, as he will, by skilfully guiding it, be able to keep it on the vessel during any accidental movement of the patient. The most important point in applying pressure is to secure that amount of it which will stop the flow into the aneurism, without injuring adjacent or intervening parts. Experience, tactile skill, manual dexterity, and sound judgment will best aid the operator here, and it will be seen that no mere tyro or student can be trusted in such a delicate operation. The surgeon must make up his mind to give up a day to the work and to take the immediate supervision of every detail, if he is to succeed. Apart from the consideration of internal injury which may be inflicted by the pressure, there is the all-important point of fully and completely arresting all flow of blood through the aneurism, which is essential to a rapid result.

If a rapid cure is aimed at, the shorter the period of pressure in this region the better. The operator must bear in mind that, every time he allows a current of blood to slip past the tourniquet, the chance of a rapid cure is reduced. If these rushes of blood are allowed to take place, the cure cannot be rapid, for each current breaks in on the coagulating process and carries the stationary blood onward, so that the process has to be recommenced. Granted that each time a volume of blood is held stationary a layer of fibrin may be deposited, that does not lead to a rapid result. It may lead to a cure by alternated layers of fibrin and blood, but this means the prolonged and probably the repeated application of the tourniquet. To succeed in a first attempt of two, three, four or more hours, we must have full command of the aorta, and aim at holding the blood in the aneurism undisturbed. In all cases slight currents will pass through the sac, and thus, instead of one mass of coagulated blood filling the vessel, we are sure to have successive deposits of coagula.

The writer has again and again succeeded in stopping the pulsations in an aneurism by holding the vessel with a firm and careful hand for half an hour, after unsuccessful pressure had been tried for a good many hours. When the pressure does not succeed in reducing the size or pulsation of an aneurism in four or five hours, we must carefully look to the state of the patient, and the slightest indication of failure of the pulse or shock must warn us to remove the pressure and chloroform, and ascertain how the patient has borne the treatment. Unless there is an entire absence of any evidence of shock or injury to the ganglionic nerve-centres, of failure of the heart's action, or injury to the stomach or duodenum from pressure, we must postpone our efforts. By trying the pressure too long or too severely our object will be defeated. When the pressure is removed, it is not infrequently noticed that, although the aneurism still pulsates, its pulsations are much reduced in force and extent. In these cases it is well to watch the patient, and to keep him at rest, free from the slightest excitement, as it is probable the pulsations will gradually disappear, and the aneurism may thus be cured.

Where proximal pressure fails, or is inadmissible, the application of distal pressure is advisable, and some authorities urge the application of distal as well as proximal pressure in all cases. After the consolidation of an aneurism, it is necessary to apply warmth to the extremities and flannel to the abdomen, and to feed the patient cautiously.

New vessels will appear in the abdominal wall in a few days, and after a lengthened period pulsation may be felt in the iliac and femoral arteries. WILLIAM MURRAY.

ABDOMINAL HERNIA.—This term is applied to protrusions through the antero-lateral parts of the abdominal parietes below the umbilicus, exclusive of those through the inguinal canal. The hernia is usually in the middle line, and most commonly follows operation wounds, as that for ovariotomy. The rupture may appear within a few weeks of the healing of the ovariotomy wound; but, as a rule, it does not present itself until many months have elapsed. It may not be noticed until after an interval of years. It may follow upon accidental wounds, upon abscess, contusions, rupture of the abdominal muscles, destructive burns, and may be apparently the consequence of pregnancy, ascites, &c.

It is usually met with in female adults. The tumours formed are, as a rule, large. The sac often has no neck. In some ruptures of old standing the tumour may become pendulous. These herniæ are seldom the seat of acute change. The more pendulous may become incarcerated when they contain colon, some of the smaller and more circumscribed protrusions may be the seat of inflammation, but the strangulation of a ventral hernia is an occurrence of great rarity.

The rupture should be supported by a suitable abdominal belt.

FREDERICK TREVES.

ABDOMINAL SECTION. *See* LAPAROTOMY; CÆSAREAN SECTION; OVARIOTOMY; OÖPHORECTOMY; UTERUS, Extirpation of.

ABDOMINAL SURGERY.—No department of surgery has made more rapid progress during the last quarter of a century than that of the abdomen. The fear of peritonitis which prevailed so strongly in the early part of the century deterred surgeons from opening the cavity of the abdomen, except under the most desperate circumstances, and the delay thus encouraged was of itself in great measure the cause of the fatal result so frequently witnessed. The first ovariotomists had to encounter not merely the ordinary difficulties inherent to all novel procedures, but had to withstand the violent prejudices of those whose knowledge was limited to the bad teaching of former years, and whose experience was *nil*.

Probably the experimental teaching of Spencer Wells, that the edges of the cut peritoneum, when brought together, would unite in a few hours, was the greatest step towards the success of modern abdominal surgery; and next must be put the practice of perfect cleanliness, so little thought of in former years, both as regards the body of the patient and his surroundings, and the hands and instruments of the surgeon. Whether the strictly antiseptic practice of Lister has done much for abdominal surgery must still be considered *sub judice*. Ovariotomy had become a success before the days of carbolic spray, and it is yet an open question whether more is not lost than gained by exposing the interior of the peritoneum and the contents of the abdomen to a carbolic or other antiseptic spray for one or two hours at a time.

The treatment of certain INJURIES OF THE ABDOMEN, notably of rupture of the bladder, has been greatly influenced by modern views, and the question of opening the abdomen with the view of stitching up the bladder may now be fairly entertained. In the treatment of INTESTINAL OBSTRUCTION, the operation of laparotomy for the division of a band or the unfolding of an intussusception has yielded excellent results, and has emboldened surgeons to remove gall-stones, and even to excise portions of the intestinal canal (ENTERECTOMY). GASTROSTOMY, for the relief of stricture of the œsophagus, has become a success, at least in cases of traumatic stricture; and forcible dilatation of the pylorus has yielded better results than excision of that sphincter.

Early COLOTOMY has been proved greatly to prolong life, in comparative comfort, when the large intestine is the seat of cancer, and in a few instances an attempt has been made to excise the diseased structure (COLECTOMY). Removal of the lower end of the rectum is an operation which must be said to be still on its trial, since the cases suitable for its performance are few and far between, whilst the risks of the proceeding are great, and its after-results are not, so far, very encouraging.

The whole surgery of the Female Pelvic Organs has undergone a change. OVARIOTOMY is no longer confined to enormous tumours, the bulk of which is estimated by the gallons of fluid contained, but ovarian tumours are diagnosed and removed when small, and diseased and painful ovaries with no special enlargement are extracted (OÖPHORECTOMY), whilst the FALLOPIAN TUBES are also dealt with if necessary. UTERINE TUMOURS are removed when necessary by abdominal incision, with little more risk than those of the ovary, and EXCISION OF THE UTERUS for malignant disease is now a recognised surgical proceeding.

The surgery of the Kidney has grown up with a rapidity almost marvellous. Incision for the relief of renal abscess (NEPHROTOMY) has been followed by the successful removal of calculi from the kidney or its pelvis (NEPHRO-LITHOTOMY); and even removal of the entire kidney, for malignant disease (NEPHRECTOMY), has been crowned with success.

The surgery of the Urinary Organs has received a notable extension by the successful removal of TUMOURS OF THE BLADDER in many cases till lately deemed irremediable; and the revival of the supra-pubic method of LITHOTOMY, rendered at once easy and safe by the distension of the rectum, offers a prospect of increased success in the treatment of large calculi.

CHRISTOPHER HEATH.

ABDOMINAL TUMOURS, Diagnosis of.—The pathological conditions which produce recognisable swellings or tumours of the abdominal walls, or of the organs contained in the cavity, are very numerous, and though each will be found in its proper place in the special articles, some general notice of these diseases is necessary. It is obviously impossible to deal with the causes, pathology, diagnosis, symptoms and treatment of each, but the following is the method which should be employed in their general diagnosis.

The patient should be laid on the back with the head and shoulders well supported by an inclined plane of pillows, and the knees should be raised, and if necessary also supported by a firm pillow placed under them, so that the abdominal muscles are relaxed. The whole surface of the abdomen should be thoroughly exposed to view, and the relaxation will be aided by keeping the patient in conversation, or causing a succession of deep respirations to be made, while the mouth is held open. Careful inspection, palpation, percussion, and auscultation should then be employed. If the parts which appear to be healthy are first systematically examined by the above methods, a diagnosis by exclusion is made, which can then be confirmed, or corrected, by varying the position of the patient, and repeating the examination. It is always better to pass from healthy to diseased structures, than to examine the tumour first.

The systematic examination will be easier if the tumours are considered in three groups: 1. Tumours of the abdominal parietes; 2. Tumours of the peritoneum, and of the organs contained in its cavity; 3. Tumours of the tissues and organs which lie behind the peritoneum.

1. *Tumours of the Abdominal Parietes.* The only growths in the parietes which will be found difficult to differentiate from tumours contained in the peritoneum, are those which are prone to cause inflammation of the peritoneal surfaces, and thus to contract adhesions to the organs contained in the cavity, especially to the omentum and intestines. These are inflammation (cellulitis), abscess, hydatid cysts, carcinoma and sarcoma.

Inflammation.—Considerable swellings of a diffused nature may arise, from some part of the areolar or fibrous tissues of the abdominal wall.

Abscess.—A later stage of inflammation, but one not necessarily reached, if rest and appropriate soothing treatment be used in time. It is most common in the sheaths of the muscles. as the result of strain or other injury.

Cysts.—The most common are hydatids and sebaceous cysts.

Fatty Tumours are not at all rare.

Fibrous Tumours.—These are of frequent occurrence, and usually arise from the sheaths of the muscles.

Carcinoma is rare, but is occasionally met with, especially in the neighbourhood of the umbilicus.

Sarcoma, in some of its many forms, though not so common as the simple fibrous tumour, is much more often met with than carcinoma.

Obesity, Œdema, and Elephantiasis must also be noted as affections of the parietes not infrequently mistaken for intraperitoneal tumours.

Hernia.—The ventral and umbilical forms of hernia may contain either serum, omentum, or intestine. The ovary and a portion of a fibro-myoma of the uterus have also been found in ventral herniæ. This disease is placed in this group because, though really intra-peritoneal, it is from its earliest formation a projection into or through the tissues forming the parietes.

Contraction of Abdominal Muscles.—A single muscle or a group may suffer from spasmodic contraction, and simulate a solid growth (phantom tumour).

2. *Intra-peritoneal Tumours* may arise from—

Peritoneum.—Any part of the peritoneal membrane may be itself the seat of a solid or cystic growth. The former are usually malignant, and though occasionally primary are more often secondary.

Liver.—The diseases of the liver which give rise to abdominal tumour are degenerations causing enlargement of the whole organ, such as the early stage of cirrhosis, amyloid degeneration, and carcinoma; simple serous cysts, abscess, hydatids, and carcinoma affecting one lobe rather than the whole organ.

Gall-bladder.—Gall-stones are the most common cause of enlargement of this organ, but it is also liable to distension from catarrhal occlusion of the duct, and it is occasionally the seat of malignant tumour. One very remarkable case of solid tumour has come under the notice of the writer. Its seat was verified by exploratory incision, and it entirely disappeared, apparently from changes induced by free puncture with the aspirating needle.

Pancreas.—This organ is occasionally the seat of malignant disease, and may form an abdominal tumour of very considerable size.

Spleen.—Abscess of the spleen, simple cystic disease, hydatids, simple hypertrophy, and enlargement as a part of the general disease leukæmia, are all met with as abdominal tumours, and with the exception of the last are of great importance to the practical surgeon.

Stomach.—Cancer is the disease which most often affects this organ, so as to cause a definite tumour. Unusual distension with food or gas may also have to be considered, and in females large collections of hair, cotton, &c., may be occasionally met with, and are exceedingly difficult to differentiate from fæcal impaction in the large intestine.

Intestine.—Fæcal impactions, volvulus, intussusception, carcinoma, and sarcoma all form abdominal tumours of a kind requiring great care for correct diagnosis.

Omentum.—Cancer, hydatids, and simple cysts are, in the order in which they are given, the tumours most common in the omentum.

The *Mesentery* is liable to the same diseases as the omentum, and has been known to be the seat of very large sarcomata and cystosarcomata. It occupies a position between the intra-peritoneal and retro-peritoneal groups, and its cystic growths are very difficult to diagnose from renal tumours.

Bladder.—Distension.

Uterus.—Pregnancy, hydramnios, hydatidiform degeneration of the chorion, moles, fibro-cystic tumour, fibro-myoma, sarcoma, carcinoma, metritis, hæmatometra, physometra, and abscess of the uterine wall, all cause enlargements of this organ, which have to be considered in examining an abdominal tumour.

Round Ligaments.—Fibrous tumours of these ligaments sometimes attain a very considerable size, but they are usually more in the groin than in the abdomen.

Broad Ligament.—Simple cysts, parovarian cysts, papilloma-bearing cysts, hydatids, cellulitis, abscess, fibroma and sarcoma, all have their seat in this ligament, and are often extremely difficult to diagnose from like affections of the ovary.

Fallopian Tubes.—Hydro-salpinx (accumulation of serum in the tube), pyosalpinx (accumulation of pus in the tube), hæmato-salpinx (accumulation of blood in the tube), papillomatous disease of the lining membrane, and tubal pregnancy, are all conditions which may present themselves as abdominal tumours, though they are more often confined to the pelvis.

Ovaries.—Unilocular and multilocular cysts, dermoid cysts, fibroma, sarcoma, carcinoma, abscess and ovarian pregnancy, are all of great importance, and the cysts especially so from their very common occurrence.

Subperitoneal Cyst.—This may arise in any portion of the subendothelial connective tissue. It is placed in this class for the same reason that hernia is placed in the previous class.

Encysted Peritoneal Effusion or *Dropsy* is occasionally met with, along with malignant disease of omentum, &c., or independently, as a result of some localised inflammatory process.

Peritoneal Hæmatocele arises when a vessel ruptures into the peritoneal cavity, or when a retro-peritoneal hæmatocele does so, and the blood only becomes encysted by the agglutination of intestines, or other organs, whose peritoneal coats have become irritated by the presence of the blood.

Besides this long array of diseases of organs contained in the peritoneum, we have also to mention the following more general affections.

Tympanites.—The gas usually accumulates in the intestines, but occasionally in the peritoneal cavity. The percussion sound is hyper-resonant all over the abdomen.

Ascites or *Hydroperitoneum* may arise from diseases affecting organs outside the cavity, such as the heart and kidneys, or it may arise from tubercle, or from papillary disease or peritoneal cancer of the peritoneum, or from the irritation set up by almost any of the many tumours named above.

Phantom.—This is a curious disease chiefly met with in women who believe themselves to be pregnant when they are not so, but also occasionally associated with some derangement of the female sexual organs. It may affect the whole abdomen or a portion only, and appears to be due to an arched and rigid condition of the abdominal muscles. It is sometimes extremely difficult to distinguish from a real tumour, but it may be suspected when an enormously distended abdomen is resonant all over, or when a localised swelling is so; and the diagnosis may be made certain by the use of an anæsthetic, for with complete anæsthesia the tumour will disappear, to rise again as the patient returns to consciousness. It may simulate a tumour of almost any abdominal organ.

Extra-uterine Pregnancy.—Two varieties of this disease have already been named as occurring in the Fallopian tubes and ovaries, and it only remains to mention the abdominal form, in which the ovum gets altogether away from the uterus, tubes, and ovaries, and becomes implanted on some other peritoneal surface.

3. *Retro-peritoneal Tumours.*—*Aneurisms* of the abdominal aorta or of its main branches.

Abscesses of various kinds. These more often appear at some point outside the abdomen. Iliac and pelvic abscesses, however, often encroach on the abdominal cavity.

Cysts may have their origin in the retro-peritoneal cellular tissue.

Solid Tumours.—Either fibroma, sarcoma, or carcinoma may also arise in the retro-peritoneal cellular tissue, but the two latter usually affect the lumbar glands and are secondary in their origin.

Kidneys.—The distensions and neoplasms of the kidneys or ureters are the most important of the retro-peritoneal tumours and are hydronephrosis, pyonephrosis, calculous pyelitis, hydatids, sarcoma, and carcinoma.

Hæmatocele.—Retro-peritoneal hæmatocele is usually pelvic in its origin, but may become abdominal and form a tumour of great size.

The above recapitulation of the tumours which may be met with in the abdomen, will serve to refresh the memory of those who are not frequently called upon to diagnose tumours in this situation, but it will be necessary to refer to the special articles for detailed information.

J. KNOWSLEY THORNTON.

ABSCESS.—*Definition.*—An abscess is a localised collection of matter in any organ or tissue, and the term is often extended to include suppuration in certain of the already existing cavities of the body. It may result from any inflammatory process which reaches a sufficient degree of intensity. Thus there may be an abscess of the subcutaneous tissue, or in the substance of a bone, in the brain or the liver, in a bursa, a joint, or the sheath of a tendon; and we also speak of a peritoneal or a pleural abscess, if the suppuration in these situations be circumscribed.

Given the inflammatory process, complex and highly differentiated tissues become crowded with small round cells (whether by a proliferation of previously existing cells, or by the escape of white blood-corpuscles from the blood, or both, it would be out of place here to discuss), and the special structure of the part disappears, to be replaced by a tissue made up of these small round cells loosely held together and permeated by vessels—in other words, by granulation-tissue. A slight increase of the inflammatory process causes this lowly-organised tissue to generate a still less highly organised material—namely, pus—and an abscess is the result. The process is somewhat different in the case of an abscess developed in a previously existing cavity—for example, in the knee-joint; here we must assume that the lining wall of the space is converted by the inflammatory action into a condition, pathologically if not to the naked eye, resembling granulation-tissue, from which, in its turn, the pus of the abscess is developed. It is thus possible that the effusion may be purulent from the first, as is most likely the case in the suppuration of joints during the course of pyæmia; or it may be serous at first, and become purulent at a later stage, when the inflammation of the enclosing surface is further advanced, as is illustrated in the case of acute synovitis of a joint going on to suppuration, or in the abscess which results from inflammation of the bursa patellæ.

Causes.—The causation of abscess is at the present time one of great uncertainty, and one that is exciting considerable controversy. Thus, while it is not improbable that we may some day be able to classify all the causes under the heads mechanical and chemical, it is obvious that there are at present many which do not belong apparently to either category. Under the head *mechanical* are such abscesses as arise from pressure—for example, subcutaneous decubitus—or from the presence of clean, though mechanically irritating, foreign bodies, as when suppuration occurs round a silk ligature long after the wound has healed, or round a piece of a needle which may have entered some time previously. To this class, also, belong the numerous abscesses caused by simple tension, as when a wound is imperfectly drained and becomes distended by the effused serum; or when the duct of a secreting gland is obstructed and the gland is distended by its own secretion. Under the head *chemical* we may, though with some reservation, include that most important class of abscesses which depend upon septic agencies, embracing, at all events, the abscesses of phlegmonous erysipelas and its allied diseases, those of septicæmia and pyæmia; though it must be remarked that micro-organisms are always present in these cases, and that we are totally unable to say how far and in what way they may be irritating in themselves, independently of the acrid fluids which accompany their growth. This class also includes such cases as the suppuration which accompanies the subcutaneous injection of an aseptic or an antiseptic material, say corrosive sublimate, and perhaps the suppuration of lymphatic glands drawing their supply of lymph from inflamed regions.

We have not, however, at present sufficient knowledge to determine the cause of many abscesses, such, for example, as the chronic suppuration of glands, bones, and other parts in strumous subjects, the suppuration of joints in rheumatic people, or the apparently spontaneous development of an abscess in the interior of a deep viscus, such as the brain; nor can we say whether or not an abscess may originate by what is commonly called sympathy, or by irritation transmitted through the nervous system, though this is a convenient method of expressing, without explaining, certain obscure conditions.

Whatever may have been the original cause of an abscess, its enlargement is determined partly by the persistence of this cause if unremoved, partly by the existence of tension, which, as was stated above, is a potent cause of inflammation. It thus happens that, almost without exception, the collection of matter continues to increase, and the abscess spreads in the direction of least resistance, the opposing substances being either displaced, as is common in the more chronic form of abscesses, or actually involved in the inflammatory changes. We say, almost without exception, because cases occur now and then, in which the contents of an abscess, which have been proved to be actual pus by the withdrawal of an infinitesimal quantity, have subsequently been, without further interference, absorbed, and have completely disappeared. The matter then makes its way ultimately, though often by a long and circuitous route, to a free surface, either that of the skin or that of some internal cavity or hollow organ. When it has reached the surface, *pointing* is said to occur, and when rupture takes place the contents are evacuated. By this means tension is more or less relieved; but, in the majority of cases, a new element of irritation, viz. putrefaction, is introduced. Nature's opening is usually too small, but supposing that the tension is completely relieved, and the original source of irritation is no longer present, and the putrefactive element be not productive of serious mischief, the sides of the cavity fall together, and the granulations lining its wall, to which the name of *pyogenic membrane* is applied, being no longer irritated, cease to develop, or do so to a less extent than before. The discharge, which is then either serous or purulent, escapes from the opening, and the constant growth of the granulations gradually fills up the abscess-cavity, healing taking place, as is said, from below.

But if the original source of mischief be still present, as, e.g., in the case of an abscess caused by diseased bone or foreign body, the cavity contracts, but continues to discharge, and a narrow suppurating track or *sinus* remains, communicating at the one end with the source of irritation, and at the other with the point of rupture. If the putrefactive element be productive of mischief, and especially—as is often the case when an abscess has burst spontaneously—if the opening be insufficient, *burrowing* takes place; that, is matter finds its way amongst the cellular planes, or through the least resisting structures, and thus other secondary tracks may be developed from the original abscess. In many cases a second or a third, or even multiple openings, may occur; and if one of such openings be into an internal hollow viscus or cavity, whilst another is on the surface of the body, what is known as a *fistula* is the result. A fistula may also follow a simultaneous wound of such an internal surface and the skin, or may originate on such a surface and make its second opening by bursting externally. The best example of this condition is the *fistula in ano*, which, commencing in many cases as a submucous abscess, bursts both into the skin of the buttock and also into the rectum, leaving a fistulous track communicating both with the bowel and with the surface of the body. These fistulæ have usually no tendency to heal spontaneously. The term fistula is also applied to sinuses communicating between two internal hollow organs, as between the rectum or bladder and the vagina; or to similar tracks that have resulted from wound or rupture of an internal organ such as the gall-bladder, the lacrymal duct, or the intestine. Lastly, a fistula may result from a congenital defect, as when a urinary or fæcal fistula exists at the umbilicus, or an œsophageal fistula in the neck, depending on a nonclosure of one of the branchial arches.

Acute Abscess.—A good illustration is the acute abscess of the breast which occurs during the active condition of the gland. Here the source of irritation is, probably, a mechanical one, viz. the plugging of one of the ducts, with retention of the secretion in one of the acini, and consequent tension; though the frequency of the association of this abscess with eczema of the nipple suggests the possibility of another explanation. The resulting inflammation involves the surrounding parts to a greater or lesser degree, and at last, in the centre of the inflamed area, suppuration takes place, no doubt accompanied by the death of a larger or smaller portion of tissue. The occurrence of suppuration increases the amount of tension, and, as it continues, the cavity rapidly increases in size, principally by the formation of more pus, but partly by the breaking down of the inflamed tissue. This process advances until the matter reaches the surface, or until the abscess is opened by the surgeon; but the necrosis bears so small a proportion to the suppuration that, on evacuating the contents, the sloughs are not perceptible, and only pus is seen to escape.

Chronic Abscess, on the other hand, is very slow of development, and unless, in the course of its enlargement, it involves some sensitive structures, is unaccompanied by the signs of acute inflammation. It gradually makes its way to the surface without causing heat or pain or redness, for the most part displacing the structures that it meets with, and following the cellular planes and the course of vessels; and at last, like an acute abscess, it involves the skin, which turns of a purplish red colour over a comparatively small area. A piece of this reddened skin then sloughs, and the contents of the abscess escape. Good examples of this form are to be found in the ordinary *cold* or *lymphatic* abscess of the soft parts, or in a psoas abscess starting from caries of the vertebræ. A cold abscess begins, we know not why (though it may be plausibly held to be a tubercular inflammation), in an almost imperceptible manner. The patient is probably unaware of its existence until the presence of a distinct swelling attracts his attention, and its growth is not accompanied by any other inconvenience. Abscesses of this kind sometimes occur in considerable numbers in persons predisposed to their development by ill-health or the strumous diathesis.

Abscesses, in their course, are usually guided by the strong fasciæ of the body; they may cause absorption of the soft or firmer structures, and occasionally open into vessels; but, as a rule, vessels and nerves are simply denuded by them, and remain as bands stretching across the track of suppuration. If ulceration of an artery or vein occur, the cavity becomes distended with blood, and, in the case of an artery, a pulsating tumour is formed, which may easily be, and has often been, mistaken for an aneurism.

The *contents* of an acute abscess are usually thick, yellow pus, mixed sometimes with small clots of altered blood and shreddy particles of slough; those of a chronic abscess are sometimes thick, but often thin, and indeed occasionally quite serous, and mixed at times with larger or smaller flakes of coagulated lymph. If the contents are actually serous, the abscess will have been accompanied by an exceptionally mild and chronic inflammation, and to this form the term *serous abscess* has been applied. It must be understood that this statement is in very general terms, and that the contents of both acute and chronic abscesses are liable to every form of variation; thus in an abscess of the breast the pus may be mixed with milk; in a cæcal abscess it may contain fæces; in a hepatic abscess, bile or broken-down liver tissue; in a psoas abscess, particles of bone; in a pulmonary abscess, mucus; in a renal abscess, urine, and so on: but it is impossible in this article to enter on this part of the subject with anything approaching to detail. The pus of an unopened abscess is not always sweet, and not always free from micro-organisms; a perineal or an ischio-rectal abscess has often a marked fæcal odour, even though there be no communication with the bowel, and abscesses in the axilla and in some other situations often contain pus with a remarkably offensive smell. Almost all acute abscesses again, whether sweet or not, have been shown to contain micrococci, and this observation applies even to abscesses which have been caused by the injection of irritating, but aseptic, materials; but it does not follow that these will not follow an aseptic course if treated properly. In other words, it does not follow that the organisms contained in the unopened abscess are those which accompany or produce putrefaction.

Treatment.—The treatment of abscess will vary in accordance with the different conditions which have been described, the only essentials that can be laid down for all cases being that the surgeon should secure—1st, a free opening, in a dependent position if possible; 2ndly, efficient drainage; and, 3rdly, antiseptic management of the case, if he can.

The treatment of acute abscesses may be divided into that suitable for the pre-suppurating stage, and that which is required when the abscess is ripe. In the former, our efforts should be directed to the alleviation of pain, and, if possible, to the prevention of suppuration, which is best attained by the application of heat, either by means of hot fomentations, or some form of poultice. This may be supplemented by frequent bathing of the part in hot water, or by the inunction of the region with a preparation of belladonna (Ext. belladonnæ ʒij., Glycerini f℥j.).

The part, when practicable, should be elevated, and all undue pressure should be avoided. Occasionally, local blood-letting may be practised with advantage. In the second stage, when suppuration has occurred, it is in most cases best to make a free incision, which affords the most satisfactory exit for the pus, and reduces the inflammation by relieving the tension. But in cases where the matter is deep, and where a long scar is objectionable from its unsightliness, as, e.g., in acute abscesses of the breast or neck, an excellent result may be obtained by making an opening in a suitable position just large enough to admit a drainage-tube of good size; provided, as should always be the case if practicable, the opening be made with efficient antiseptic precautions. In the after-treatment, if the pus be putrid, a hot and moist application should be used. Boracic fomentations, viz. boracic lint wrung out of hot water, and covered with guttapercha tissue ; or an antiseptic poultice, made by mixing boracic acid or iodoform with linseed meal, will be found excellent applications. Iodoform may be applied when practicable to the interior of a putrid abscess, or it may be mopped out with some antiseptic lotion —chloride of zinc, gr. 40 ad f℥j., carbolic acid 1–20, or whatever is found convenient.

Similar, though milder, lotions may be employed on subsequent occasions if it be found necessary. In many examples of putrid abscess, whether acute or chronic, if it be thought practicable to render the cavity pure, this end may be most easily attained by removing the granulations lining it by means of Volkmann's sharp spoon, or other suitable scraping instruments, before applying the potent germicides mentioned above ; these sharp spoons are made long and short, so that they may serve for superficial or deep abscesses, and they are strong enough for the treatment of sinuses in the interior of a bone.

The treatment of a chronic abscess is essentially the same as that of an acute abscess, but may in some respects be modified ; thus it is not necessary to anticipate the period of incision by use of fomentation or poulticing ; it is not a matter of importance that the incision should be a long one, provided that it be sufficient to admit a tube of sufficient calibre. On the other hand, it is perhaps of more importance that the opening should be made in a position which will favour drainage, and thus prevent the retention of matter in a diverticulum or pocket, and it is often a matter of great importance to scrape away the thick and very lowly organised pyogenic membrane, which is, in many cases, but little prone to take on a healthy reparative action. The reader is referred to the article on ANTISEPTIC SURGERY for the methods of managing both an acute and a chronic abscess. It may be pointed out, however, that it is not essential that elaborate machinery or complicated dressings should be employed in order to conduct the antiseptic treatment of an abscess rigidly from beginning to end ; though, if they are at hand, it is no doubt better—especially in cases such as that of psoas abscess, where the life of the patient probably depends upon the maintenance of the aseptic state—that every possible known precaution should be employed.

The following plan is one which the writer can recommend for simple cases. Before making the incision, the skin, the instruments, and the operator's hands, are to be thoroughly purified with carbolic acid solution (1–20). A dressing has been previously prepared consisting of a piece of lint soaked through and through with an ointment consisting of Iodoform gr. lx., Ol. eucalypti f℥j., Paraffine f℥ijss., Vaseline ℥ijss. After making the incision, pressure is maintained over the abscess by the left hand of the surgeon, in order to prevent the regurgitation of air into it ; and, if a drainage-tube be required, it is inserted, and the dressing is applied before this pressure is relaxed. Outside the piece of lint is placed a large pad of salicylic wool, iodoform wool, or carbolised tow, and the whole is secured with a bandage. The whole proceeding should be accomplished as expeditiously as possible, and when the dressing is changed, similar precautions should be employed, viz. a piece of rag is soaked in the carbolic acid solution, and as soon as the dressing is removed, it is placed over the incision. If the tube is to be removed, a few drops of the lotion should be allowed to fall on the wound whilst it is being taken out or returned. The piece of rag (guard) is applied while any necessary cleaning in the neighbourhood of the wound is taking place, and is then replaced by the deep dressing. After this the outlying parts are purified by the lotion, and lastly the absorbent outer dressing is reapplied as before. This simple process has been described in detail because there is a prevalent belief that there is no halfway-house between rigid Listerism and the most primitive form of poulticing ; whereas, as was mentioned above, even a poultice may be rendered, in the strictest sense of the term, antiseptic. Many other and equally good plans will, no doubt, suggest themselves to the practical surgeon, in which, by the employment of iodine, benzoin, carbolized oil, or other materials, and by the exercise of a little common sense, he may keep even the largest abscesses free from putrefaction.

If the matter show a disposition to 'pocket' in an outlying part of the abscess, or if burrowing occur, it may be necessary to make a *counter-opening*, by which is meant a second opening in a position suitable for drainage, and at a distance from the first incision. This may often be accomplished by passing a probe from the original incision to the required point, and cutting upon its extremity, which is made to project under the skin. If the pocket is a deep one, it may be advisable to force the probe, or better a stout metal bougie, through the superjacent soft parts, and, after cutting on its point, to follow back the track it has made either with the finger or a pair of dressing-forceps, by expanding the blades of which the second opening may be dilated. A tube is then inserted into the counter-opening. It is often convenient to pass a tube through from one opening to the other, and, after the track has contracted to a mere sinus, to cut the tube in the middle, and afterwards gradually shorten the two remaining portions. Several counter-openings may sometimes be required.

The *treatment of a sinus* depends upon its cause. If there be a source of permanent irritation at the bottom, it is obvious that the sinus cannot heal till this has been removed. If it depend upon insufficient drainage, this must be secured by enlarging the opening and inserting a drainage-tube, or by making a counter-opening. If it be merely the result of a sluggish action of the parts, this may be rectified by scraping the sinus with a sharp spoon; or by applying some irritating or stimulating material, such as a piece of lint impregnated with red oxide of mercury ointment, or by the injection with a solution of sulphate of zinc 2 grains to the ounce, or sulphate of copper 2 grains to the ounce, or some similar substance; or the application of the solid nitrate of silver, by coating a probe with this caustic. The healing of a sinus may often be promoted by the application of a blister over the orifice, and sometimes by the judicious use of pressure over the deeper parts.

Rickman John Godlee.

ABSCESS-KNIFE.—For the purpose of incising abscesses near the surface of the body, various forms of cutting instrument have been used. In a case of a purulent collection of slight extent, as a boil or a minute abscess, an ordinary bleeding lancet will be found a suitable instrument; whilst in large abscesses many surgeons make use either of a straight or curved bistoury, or of a stout scalpel with a broad and double-edged blade. The term abscess-knife, however, is restricted to two forms of instrument, of which one, known as Syme's knife, has a thin, slightly curved, and double-edged blade, whilst the other, known as Paget's knife, consists of a narrow, straight blade, attached to its handle by a thin metal stalk.

ABSCESS OF BONE, Chronic.—This is a disease of great practical and clinical importance, for complete relief can, as a rule, only be obtained by operation. It almost always occurs in the cancellous tissue at either end of a long bone, especially in the head or lower end of the tibia.

Causes.—Very little can be said definitely as to its causation. There is very frequently a history of an injury or accident, occurring some little time before the first symptom of the disease. The patients are oftentimes strumous subjects, and there is a suspicion in many that the disease is tubercular, although this has not yet been proved to be so in any considerable number of cases.

Pathology.—Chronic abscess of bone commences by rarefying ostitis of a localised portion of the cancellous tissue, the central part of which becomes fluid pus, with possibly a very small sequestrum. The changes by which this is effected will be found described under Ostitis, Necrosis, and Osteomyelitis. The peripheral portion of the inflamed area frequently becomes very dense and hard, as in condensing ostitis, and tends to prevent the pus from coming to the surface. It may, however, gradually, in the course of years, work its way through the bone or from the first be more superficial, making itself evident as a fluctuating tumour beneath the skin. The part affected is almost always one of the ends of a long bone, the disease occurring with much greater frequency at either end of the tibia than in any other bone. It is also found in the lower end of the femur, and in the articular extremities of the humerus, ulna, or radius. Specimens are preserved in our museums of chronic abscesses in other bones, and a few instances are recorded in which the diaphysis of a long bone has been so affected. When it occurs, as it does most frequently, in the articular extremity of a long bone, there is a danger of its opening into the joint.

Symptoms.—More or less dull aching pain, which is much worse at night and in wet weather, is the prominent symptom of which the patient complains. On examination, a swelling will commonly be found at one or other extremity of a long bone. This swelling will be seen and felt to be due to an enlargement of the bone, unless the pus has already made its way through the cortical layer and formed a small area of fluctuation on the surface. Still, even in that case, the peripheral part of the swelling will be found to be produced by the enlargement of the bone beneath. Generally, however, the swelling is uniform, dense, hard, and resistant to the touch, and on firm pressure at one spot the patient will be found, almost without exception, to complain of extreme pain. This spot is generally not larger than a sixpence or a shilling, and is in about the centre of the swelling and on its most superficial aspect, as, for example, on the inner surface in the case of the tibia.

This tenderness on pressure is probably the most characteristic symptom of such a chronic abscess, especially when taken in conjunction with the increased size of the bone and the persistent pain at night. There may also be slight œdema of the soft parts over this tender area, so as to leave a mark of 'pitting on pressure.' The pain at night has generally existed a long time—for months as a rule—before an examination has led to the discovery of enlargement of bone and tenderness on pressure, and occasionally one or more years have elapsed before the diagnosis has been made.

Treatment.—If the pus has found its way to the surface so as to be superficial, an incision must be made, and the opening in the bone searched for. The osseous sinus is then enlarged, and the cavity in the articular extremity of the bone examined for a sequestrum. Fluctuation is not, however, often detected, and the trephine has to be applied to the most tender spot, and a circle of bone removed. The abscess will in this way generally be opened and a free vent given to the pus. Should this not be the case, the cavity may have been missed by the opening being made a little on one side. Esmarch's bandage will be found of great assistance in this operation, and should always be used, as the amount of pus may be very small and quite obscured by the blood, which otherwise freely flows from the highly vascular bone to which the trephine is applied.

If, notwithstanding this precaution, no pus has been seen during the operation, the sides of the aperture made by the trephine should be perforated by a drill, in the hope that the supposed cavity may in this way be discovered. Pus having been found, a free opening must be made into the cavity in which it is contained. If, however, these measures fail to discover any pus, the surgeon need not be disappointed, as the operation will almost certainly give relief by the removal of tension and abstraction of blood from the engorged bone.

As regards the method of dressing, antiseptics should, if possible, be employed. The cavity should be sponged out with chloride of zinc (40 grs. to f℥j.), and some absorbent dry dressing applied. Wood wool and corrosive sublimate gauze, or iodoform gauze with salicylic wool, are probably the best. If the above method has been properly carried out, there need be no fear of decomposition, and the dressing may not require changing for a week, or even longer. The cavity in the bone becomes in this way much more quickly filled up with rapidly organizing tissue than under the older method of dressing.

When the cavity in the bone has thus become filled with inflammatory new formation, fresh bone is rapidly reproduced, and the patient restored to perfect health.

H. H. Clutton.

ABSORBENT SYSTEM. *See* Lymphadenitis; Lymphadenoma; Lymphangitis.

ACARUS. Acarus Folliculorum.—A minute, wormlike grub which is found in healthy or diseased sebaceous follicles. In man it is harmless, but a variety exists in certain of the lower animals which causes boils. It varies in length from $\frac{1}{12}$th to $\frac{1}{6}$th of a line, and is eight or ten times as long as it is broad. It has a head, thorax, long abdomen, and four small legs on each side of the thorax. For microscopic purposes, it can be obtained by mixing sebaceous matter, collected from some of the larger follicles of the face or back, with an equal quantity of oil.

The parasite is not the cause of comedones, acne, or seborrhœa.

Acarus Scabiei.—This is the name given to the mite which is the essential cause of the disease known as the *Itch* or *Scabies*. *See* Scabies.

It belongs to the class Arachnoidea. There are both female and male acari, but the former is the one most easily found, as it can be dug out from the little cuniculus or tunnel in the epidermis into which it has burrowed, whereas the male can only, with difficulty, be discovered on the surface of the skin.

The full-sized female is visible to the naked eye as a white, semi-transparent speck. Under the microscope, it is seen to be oval in shape, slightly indented on either side, and about $\frac{1}{80}$th of an inch long by $\frac{1}{100}$th of an inch broad. Its convex dorsal surface is covered with little spines, while its flat ventral surface is characterised by wavy furrows running from side to side. The head is small and oval, and on it are minute hairlike processes. The legs, which are clearly seen on the ventral surface, are eight in number, four being situated anteriorly, near the head, the remaining four on the posterior half of the body. The front legs are short and broad, and provided with suckers; the posterior ones being slightly longer and narrower. Bristles are seen both on the body and on the legs. The male is much smaller than the female, has suckers on the hindermost pair of legs, between which are the organs of generation. Inside the cuniculus or burrow, the female acarus lays from twelve to twenty eggs, from which are hatched the young acari. At first they have but six legs, and only become fully developed after shedding their skins three times.

Malcolm Morris.

ACCOMMODATION OF THE EYE.

When the eye is completely at rest it is focussed for one definite distance only; that distance is called the *far point* (F). But it is well known that, during the greater part of life, we have the power of seeing distinctly, and therefore of focussing objects, at different and nearer distances. This is called the *Power of Accommodation.* The nearest point to our eyes for which we possess the power of accommodating is called the *near point* (N). It is evident that, other things being equal, it requires a stronger lens, or a stronger system of refractive media, to bend the rays proceeding from a point near the eye, sufficiently to bring them to a focus on the retina than is required to focus those coming from a more distant point. The *range of accommodation*, then, is given by the difference between the refractive power when the eye is accommodated for the near point, and when it is at rest or adapted for the far point. It is clear, therefore, that the range of accommodation is equivalent to, and may be expressed by, a lens the optical strength of which is equal to that difference. Such a lens, if placed in front of the eye *at rest*, would evidently give to rays proceeding from a point at a distance from the eye, equal to the distance of the near point (N), a direction similar to those proceeding from the far point (F). The eye being at rest, the rays would be focussed on the retina, so that the lens would take the place of accommodation.

The actual position of the near point will depend upon: 1. The range of accommodation; 2. The position of the far point. The first is evident from what has been said, and it need only be added that in all individuals the range of accommodation is approximately the same at the same age, though it varies very much with age; thus whilst at ten years of age it is equal to a lens of 14 dioptres; at forty it is only equal to one of 4·5 D, and at seventy-five is = 0. The far point, or the point for which the eye, when at rest, is focussed, cannot always be represented by an actual point in space; this can evidently only be the case when the far point lies at a *finite* distance *in front* of the eye, and is therefore one from which the rays are divergent as they enter the pupil, as in Myopia (*see* Refraction, Errors of). The ideal or emmetropic eye is focussed for a point the rays from which enter the pupil parallel to each other; such a point must be at an *infinite* distance, and has therefore no reality in existence, although the divergence in the case of rays whose base is the pupil and whose apex is a point at the distance of 20 feet, is so slight as to make them *practically* parallel. We have so far, then, two forms of eye, in one of which the rays from the far point are more or less appreciably divergent (myopic eyes), and in the other parallel (emmetropic eyes). But this does not exhaust the possibilities: one other form is met with, in which the rays, in order to be focussed by the eye at rest, must enter the pupil converging to each other, and therefore converging towards a point which lies at a finite distance *behind* the eye. In such eyes (hypermetropic eyes) the far point lies behind the eye, and is evidently not an actual, but only an imaginary, point.

From what has been said, it is evident that we may represent the *breadth* or *amplitude* of accommodation by the lens which brings the focus from the far point to infinity (∞), *plus* the lens which represents the difference between the refractive power for focussing an object at ∞ and that necessary for focussing one at the near point. The lens which brings the focus from F to ∞ is *practically* determined by the lens which, when the eye is at rest, gives the fullest possible acuity of vision at twenty feet (*see* Visual Acuity). In emmetropic eyes no lens is required; in myopic, a concave or *minus* lens; in hypermetropic, a convex or *plus* lens. As an example, take the lens bringing the focus from F to ∞ in three cases of Emmetropia, Myopia, and Hypermetropia, viz., 0. − 2·0 and + 2·0 (dioptres) respectively, and the lens giving the difference between ∞ and N in each case as 10·0, 12·0, and 8·0; we have for the breadth of accommodation (A)—

$$A = 10{\cdot}0 + 0 = 10\ \mathrm{E}.$$
$$A = 12{\cdot}0 + (-2{\cdot}0) = 10\ \mathrm{M}.$$
$$A = 8{\cdot}0 + 2{\cdot}0 = 10\ \mathrm{H}.$$

i.e., the *breadth of accommodation* is the same in all these cases, although the *near point* is different in each case, nearer than normal in myopia, and farther off in hypermetropia.

Mechanism.—The change produced in the refractive power of the eye, which brings about accommodation, is effected by the contraction of the ciliary muscle and the elasticity of the lens. On contraction of the muscle, the lens, more particularly in its anterior surface, assumes, owing to its elasticity, which comes into play when the tension on its capsule is reduced, a greater curvature, thereby increasing its refractive power. G. A. Berry.

ACCOMMODATION, Disorders of.—The change in the refracting power of the eye, produced by accommodation, may be looked upon as the result of the simultaneous action of two factors, the one a contraction of the ciliary muscle, and the other an alteration in the shape of the crystalline lens. This latter, which takes place in response to the diminished tension of the lens-capsule, a result of the contraction of the ciliary muscle, is the expression of the elasticity of the lens. The degree of perfection of the lenticular elasticity depends upon its structure and chemical constitution. The functional activity of either factor, in the production of accommodation, may be altered. The power of contraction in the ciliary muscle may be lost or impaired by atrophic or inflammatory changes, such as glaucoma, cyclitis, &c. Or, again, it may cease to be brought into play, owing to some interrupted function in the nervous mechanism with which it is supplied. On the other hand, a diseased state of the lens may diminish its elasticity; or disease of, or accident to, the zonule, alter or destroy the conditions by which, under normal circumstances, that elasticity responds to changes in the shape and position of the ciliary muscle when contracted. The lesion, giving rise to such an interruption, may be at a considerable distance from the muscle, and produce the functional disorders by interfering with the normal reflex mechanism giving rise to accommodation. Or it may exist at the centre, in the trunk of the third nerve, in the ciliary ganglion, or in the peripheral terminations of the ciliary nerves.

Paralysis.—All the conditions mentioned tend to diminish the amplitude of accommodation, or deprive the patient of the power of accommodating altogether. But the term *paresis* or *paralysis of accommodation* can only properly be applied to such cases as owe their origin to more or less impeded innervation. Some acute diseases are apt to be followed by more or less complete paralysis of accommodation, more especially diphtheria, and enteric and typhus fevers. Chronic diseases may also exhibit this symptom, such as syphilis, diabetes, various central and reflex nervous disorders, &c. Further, this form of paralysis is produced by some poisons, putrid fish or meat, and mydriatics (those principally employed in ophthalmic practice being atropine, homatropine, duboisine, daturine, and hyoscyamine).

The *diagnosis* of paresis of accommodation, if slight, is not always easy; but it is always to be suspected when there is pronounced diminution in the amplitude of accommodation, which should correspond to the age of the patient, provided, of course, the diminution is due to a recession of the near point, while the far point remains unaltered. Whenever distant vision remains unchanged, or, if improved at all, improved only by convex glasses, whilst distinct vision for near objects has suddenly become impossible, or rendered more difficult, then we may conclude there is more or less paresis of accommodation. Often, too, there is more or less mydriasis, which assists the diagnosis. Not infrequently children suddenly lose distinct vision for distant as well as near objects, owing to the paralysis of accommodation rendering an existing hypermetropia absolute.

The *treatment* should be general and tonic (according to the cause), and we may sometimes hasten a cure by the careful use of myotics; some believe, too, in faradisation and strychnia.

Spasm.—The amplitude of accommodation may also be diminished owing to *spasm of the ciliary muscle.* The spasm is either constant (a very rare condition), or occasional, and occurring during efforts of fixation. It generally occurs simultaneously in both eyes, rarely unilaterally. Spasm of the ciliary muscle occurs reflexly along with congestion myosis, and is excited by irritable states of the conjunctiva, cornea, and iris, and often associated with retinal hyperæsthesia. It is met with as a rare concurrence in some cases of errors of refraction and disturbances of the cervical sympathetic. Various toxic agents also bring about spasm of accommodation, principally the so-called myotics (those used for this purpose are eserine, pilocarpine, and muscarine). There is not much difficulty in diagnosing the condition. The diagnostic points are—abnormally small amplitude of accommodation, along with more or less myosis, and marked recession of the far point under the influence of mydriatics.

The treatment consists in keeping the eyes at rest: the removal of all sources of irritation, whether direct, indirect, or reflex; the use of mydriatics, and, if necessary, the accurate correction of errors of refraction.

It has been shown that in both paresis and spasm of accommodation therefore, there is to be found a diminution in the amplitude of accommodation. In paresis this is due to the recession of the near point, the far point remaining stationary; whilst in spasm the opposite takes place, the far point being brought closer to the near point, which here remains stationary (sometimes indeed approximating to the eyes slightly).

The effect of a weak myotic is often to increase the amplitude of accommodation, by increasing the contractile power of the muscle, allowing thereby the near point to approach more to the eye whilst, there being no actual spasm, the far point remains stationary.

The diminution of elasticity, as well as the change in the total refractive index of the lens, which begin at about the age of ten, and continue throughout life, both give rise to a gradual decrease in the amplitude of accommodation. When the amplitude has been reduced to an amount leaving a residue equivalent to a lens of less than 4·50 dioptres, the condition known as presbyopia or old vision is said to exist, a condition which, although in one sense a disorder of accommodation, is one which is in no respect pathological. *See* PRESBYOPIA.

G. A. BERRY.

ACEPHALO-CYST. *See* HYDATIDS.

ACHORION SCHÖNLEINII is the name given to the vegetable fungus which constitutes the greater part of the yellow crusts of favus. A small piece of the crust, treated with liquor potassæ, and examined under the microscope (magnified 500 diam.), shows the parasitic fungus to consist of spores and mycelium threads in great abundance. The spores consist of minute rounded bodies, the mycelium of long, narrow, thread-like tubes, which curve and branch in various directions. Some of the mycelium filaments appear to contain spores, while others are empty; free spores are also met with in abundance.

ROBERT LIVEING.

ACHROMATOPSIA. *See* COLOUR-BLINDNESS.

ACIDS, Swallowing of.—The only acids which, when swallowed, produce effects that are of surgical importance are the corrosive acids. The strong mineral acids (*sulphuric*, *nitric*, and *hydrochloric*) cause the most serious results. *Hydrofluoric acid*, which has been very rarely swallowed, also has a corrosive action, as have likewise *carbolic* and *oxalic* acids, but these latter are of more interest from their toxic, than from their traumatic, effects. Strong sulphuric acid, or oil of vitriol, is the acid which is most commonly taken. It may be deliberately swallowed with suicidal intent, or may be administered with murderous intent, or it may be swallowed accidentally in mistake for castor oil, or some other medicine or a liqueur. The result which follows on the swallowing of oil of vitriol, or other strong acid, depends more upon the concentration of the acid than the actual quantity taken. A teaspoonful of strong acid will produce results more serious than three or four times the quantity if previously diluted.

Symptoms.—Marks of the corrosive liquid are often seen at the angles of the mouth, and dirty white stains may be observable on the tongue and throat. There is at once a sharp burning taste in the mouth and throat, quickly followed by excruciating pain in the abdomen. The strong acid has a great affinity for water, and as it enters into combination with the water of the tissues, the heat evolved is intolerable. Vomiting is common in the early stages. The vomit is acid, and may cause effervescence if it fall on a limestone pavement. The patient is soon reduced to a state of collapse, which is extreme if perforation of the stomach takes place (*see* COLLAPSE). There is usually constipation, but, exceptionally, there may be some tenesmus and passing of shreds of mucus, and small quantities of altered blood and similar matters, as well as the contents of the stomach, may also be vomited. The urine is usually diminished in quantity, and is loaded with sulphates when sulphuric acid has been taken.

The *prognosis* is always grave. It depends upon the amount and strength of the acid taken, and on the state of the stomach (whether full or empty) at the time. A small quantity of strong acid in an empty stomach is necessarily very likely to lead to perforation. When perforation occurs, death takes place within a few hours. If the air-passages are affected by the acid—if, for example, some finds its way to the glottic aperture—suffocation may soon follow the inflammatory swelling of the mucous membrane. If the stomach be not perforated, and if the air-passages escape, the patient lives longer. Death from collapse may occur, even though no perforation takes place. Death may result at a more remote period from inanition, resulting either from the destruction of the glandular structure of the stomach, or the occlusion of the œsophagus by the contraction of a cicatrix, the result of the corrosive action of the acid. *See* ŒSOPHAGUS.

Treatment.—In treating these cases, it is very essential to bear in mind that the patient is necessarily in danger of perforation. The stomach-pump must *not* be used, nor any emetics be administered; but no time should be lost in endeavouring to neutralise the acid by the administration of alkalies. The carbonates of the alkalies should not be employed, lest the stomach, already in danger of perforation, be burst by the disengagement of carbonic acid gas. Calcined magnesia, stirred up with water or lime-water, or liquor potassæ, freely diluted, are the best antidotes. If these be not at hand, the plaster off the walls or ceiling may be given, powdered and suspended in water. If none of the alkalies are at hand, it is probably advisable to give the carbonates (e.g. washing soda), as the danger of keeping the acid undiluted is certainly greater than that arising from the disengagement of carbonic acid in the stomach. If neither the alkalies nor their carbonates be obtainable, the mere dilution of the acid may be aimed at. Copious draughts of milk, or milk and water, or even water alone, may be given; and oily or mucilaginous drinks are recommended as a protection to the coats of the stomach. If the patient be collapsed, it may be necessary, after the severe corrosive symptoms have subsided, to administer stimulants by the rectum.

The symptoms arising from taking the other corrosive acids are in the main so similar to those of sulphuric acid that it is hardly necessary to enter into the details again. Nitric acid, owing to the fact that it evolves irritating fumes, is very prone to attack the air-passages, and, after the corrosive symptoms as affecting the alimentary tract have subsided, the patient may succumb in the course of a few days to bronchopneumonia. Perforation does not occur quite so readily with nitric as with sulphuric acid. The nitric acid forms a tough yellow slough by its action on the mucous membrane. This separates after a few days, and the patient may vomit a cast of the œsophagus and stomach. This involves destruction of the glandular structure and ultimate death from inanition, if, indeed, perforation do not follow on the separation of the slough. G. V. POORE.

ACNE.—*Synonyms:* Acne vulgaris; Acne disseminata.

Definition.—Acne is a chronic disease of the skin, confined to the face, back, and shoulders. It is met with chiefly in young adults. The eruption consists of pimples, which are produced by an inflammation of the sebaceous glands and hair-follicles. The disease leaves small depressed scars.

Symptoms and Pathology. — Many qualifying names have been applied to common acne, such as 'simplex,' 'punctata,' 'indurata.' These names indicate the varying appearance of the eruption, and its different degrees of severity, rather than varieties of the disease.

Common acne is so constantly associated with comedones that it is almost impossible to deal with the two eruptions separately. A comedo consists of a hair-follicle, distended by a small mass of inspissated sebum mixed with *minute hairs*; these minute hairs are shed within the follicle, and in course of time accumulate in considerable numbers; they become matted together with sebum, and thus the natural escape of the sebaceous matter is prevented; a little black spot marks the orifice of the distended follicle. Subsequently inflammation occurs, and the comedo becomes converted into an acne pimple, which ultimately suppurates, discharges its contents, and heals with the formation of a small depressed scar. All acne pimples are not formed in this way, as inflammation may arise in the follicles without the previous formation of comedones; and, in very severe cases a more deep-seated inflammation occurs, producing a kind of blind boil which is very slow in suppurating. In theory, acne may appear on the skin of any part of the body, except the soles and palms, which are free from sebaceous glands and hairs; it is, however, rarely met with except on the face, neck, shoulders, back, and chest. Acne develops in successive crops which follow each other in quick succession, so that we see in any given case pimples in all stages of development and decay, from the early comedo to the final process of scarring; thus the *disease*, taken as a whole, is *chronic*, though the course of any one spot may be acute.

Etiology.—Acne, which is equally common in males and females, usually appears at the age of puberty, and arrives at its full development at about the age of eighteen or twenty; a few years later it has generally disappeared. In severe cases, however, it may continue to a much later period of life. It is met with, for the most part, in young people who have what is called a sluggish circulation, and who suffer from cold hands and feet, and sometimes chilblains. Acne is, moreover, much less troublesome in summer than in winter—indeed, it often disappears altogether during the height of summer, to return with the ensuing winter.

Varieties of Acne.—One variety of acne requires a brief notice. It apparently consists of groups of comedones, and is unattended with any *visible* inflammation; it is followed, however, by a very superficial kind of ulceration and scarring, giving to the skin an appearance which can best be described as a worm-eaten look. The scars are very shallow, clean cut, and different in appearance from those of ordinary acne.

Diagnosis.—The differential diagnosis of acne is usually very easy when the age of the patient and the history and distribution of the eruption are taken into consideration. The only eruptions with which it is at all likely to be confounded are (1) certain forms of dermato-syphilis, and (2) acne rosacea. The presence of comedones, and the absence of any symptoms of syphilis, will serve to separate it from the former, while the age of the patient and the absence of burning sensations and itching, will assist in distinguishing it from the latter.

Allied Diseases. — Certain eruptions allied to acne are usually classed with it — (1) acne artificialis, (2) acne varioliformis. The former of these is simply a convenient, though inexact, term for certain medical rashes resembling acne, such as those sometimes produced by bromide or iodide of potassium, or the local application of tar to the skin. Acne varioliformis is a rare, but well-defined, affection resembling acne; it is confined, for the most part, to the forehead and hairy scalp; the pustules, which are of uniform and rather large size, form scabs and deep scars like those of smallpox. This eruption is generally regarded as of syphilitic origin, and, without doubt, there is a form of dermato-syphilis which closely resembles it. But the eruption referred to is not a syphilitic one, as is shown by its occurrence in those who have never had syphilis, and also by the fact that it does not generally yield to anti-syphilitic remedies, but rather to large doses of arsenic. It is, however, a very obstinate affection.

Treatment.—An ordinary case of acne is best treated in the following manner:—A sulphur ointment (ʒj. to ℥j.) should be well rubbed on the skin affected every night; it should then be lightly wiped off, so as to allow only a small quantity of the ointment to remain on all night. In the morning the ointment should be washed off with a soft flesh-brush, soap, and warm water; if the skin is tender, a little starch powder may be applied to the face during the day. This plan of treatment must be continued for months or years according to circumstances. Instead of using an ointment, a drying sulphur lotion, containing a little ether and spirit, may be used, but very little of the sulphur in the form of powder should be allowed to remain on the face, otherwise it is apt to get into the eyes and produce irritation. When sulphur does not suit the skin, a weak soap lotion (soft soap ʒiij., proof spirit f℥viij.) may be applied every night, and a little allowed to dry on; this should be washed off in the morning with warm water in the usual way. In very severe cases of acne, the larger acne pimples should be lightly touched with a small blunt-pointed piece of wood, dipped in pure carbolic acid; this must be done carefully, so as not to allow the acid to run down the face; a few spots should be touched daily; this process causes the pimples to dry up, and thus tends to diminish the formation of deep scars. In most cases of acne, the administration of cod-liver oil during cold weather will be found beneficial. Small doses of arsenic are also sometimes useful.

ROBERT LIVEING.

ACNE ROSACEA. — *Definition.* — Acne rosacea is a chronic disease of the skin of the face, a characteristic feature of which is a passive congestion of the vessels, associated with sensations of burning and itching and the formation of pimples.

Symptoms and Pathology. — Acne rosacea has little relation to acne vulgaris, except in name and appearance. The eruption, which is confined to the face, is met with chiefly in women of middle age. It has one feature in common with acne vulgaris, namely, its great tendency to appear in those whose cutaneous circulation is sluggish, that is, who suffer from cold hands and feet and passive venous congestion. Hence it is that those who have had acne vulgaris in early youth are very liable to acne rosacea in middle life.

It is usual to describe two forms of acne rosacea: (1) the *hypertrophic form*, which is comparatively rare and chiefly met with in men; and (2) the *non-hypertrophic form*, which is very common and almost confined to women. The former consists in an increased growth of the fibro-vascular tissue of the nose and adjacent skin of the face; in severe cases the nose is much enlarged, nodulated and red. This hypertrophy is generally associated with the development of acne-like pimples. The disease is often, but by no means always, the result of over-indulgence in alcohol. Long and frequent exposure to cold winds in those whose cutaneous circulation is feeble, is very apt to produce a similar result, though in a less degree.

The *non-hypertrophic* variety of acne rosacea is very common. In its mildest form it consists simply of a passive over-distension of the vessels of the skin of the nose and cheeks, forming a pretty well-defined symmetrical red patch; the congestion may vary much at different periods of the day, but is generally aggravated after a meal and during the evening. Besides the nose and cheeks, the chin and forehead are often affected. In a more advanced stage, the congestion becomes more persistent and small red pimples appear, resembling those of acne vulgaris. The eruption is almost always accompanied with sensations of burning and itching, especially the former.

Etiology.—One cause of acne rosacea has already been referred to. A much more common cause is chronic indigestion associated with a feeble circulation. It is not uncommon to find all the symptoms of the disease aggravated every month at the period of menstruation, and the age at which that function altogether ceases is especially liable to its attacks.

Diagnosis.—Acne rosacea is hardly likely to be mistaken for any other disease except acne vulgaris. The age of the patient, the congestion of the skin, and the subjective sensations which are almost always present, serve to distinguish it from the latter disease.

Treatment.—The treatment of the hypertrophic form of the disease consists in the free division of the vessels; this relieves the congestion, and at the same time gradually gets rid of the new vascular tissue; at the same time, complete abstinence from alcohol must be enjoined. The non-hypertrophic variety of the disease arises so often from indigestion, that the greatest attention should be given to diet, rest, and those medicines which are generally useful for improving the digestive powers. Mild saline purgatives are sometimes very beneficial, especially when the bowels are naturally constipated. The most generally useful local application is the ordinary calamine and oxide of zinc lotion, to which a small quantity of sulphur has been added. (Oxide of zinc, ʒij.; calamine, ʒij.; precipitated sulphur, ʒss.; rectified spirit, f℥ss.; glycerine, f℥ij.; lime water, f℥ij., rose water to f℥viij.). Robert Liveing.

ACROCHORDON is a small outgrowth of the skin, consisting of a minute thread or cylinder of fine fibrous tissue, containing small vessels. When cut across, these vessels sometimes bleed freely. Acrochordon is met with chiefly on the loose skin of the neck. The treatment consists in snipping it off with a pair of scissors, and then lightly touching with caustic.

Robert Liveing.

ACROMION PROCESS, Fracture of the. *See* Scapula, Fracture of the.

ACUPUNCTURE may be performed, according to circumstances, with a round-pointed or sewing, or with a cutting-edged or surgical needle. Its uses are various: as a stimulant; as a counter-irritant; for the purpose of evacuating or dispersing fluids from various parts of the body; and the term may also be applied to the use of needles in the operation of tattooing, which is almost confined to ophthalmic practice. With regard to the use of acupuncture for the purpose of evacuating fluid in cases of anasarca, the practice is so well known as hardly to call for any remarks; and the same may be said with respect to its use in dispersing the contents of certain encysted collections of fluid, such as hydrocele and ganglia. In the latter case, however, a cutting-edged needle must be used to ensure a successful result; whereas in dropsy a round-pointed needle is sufficient, and in fact preferable, as being less likely to inflict injury upon the skin. But the term acupuncture is more generally applied to the use of needles for the relief of various painful affections, such as neuralgia, and muscular pain and stiffness consequent upon injury or chronic rheumatism. For this purpose the needles should be flexible, with handles or heads made of bone, glass, sealing-wax, or twisted wire; they should be introduced with a slight rotatory movement, or by a succession of light taps. This practice has for ages been popular amongst the Orientals, more especially the Chinese and Japanese, in whose hands the effects are said to be marvellous; but the records of English surgery do not throw much light upon the subject. It is true that its use in the treatment of obstinate sciatica is well recognised, but its success has been by no means constant. For this purpose the directions usually given are, that the tender part of the nerve having been ascertained by pressure, the needle is to be thrust in until it is felt by the patient to have entered the nerve, and there left for a few minutes. Erichsen says that five or six needles may be introduced at one operation. The mode of action is uncertain, but one explanation is that tension is relieved by the puncture of the nerve-sheath. In the recent edition of Agnew's *Surgery* (vol. ii. p. 265) is shown an instrument for producing superficial acupuncture in the treatment of local pains; but here the effect may be clearly defined as counter-irritant.

Regarding the use of acupuncture for the relief of chronic muscular pain and stiffness, more especially where arising from injury, probably the best account will be found in the *Lancet* for April 29, 1871, in a paper by Mr. Pridgin Teale, 'On the Relief of Pain and Muscular Disability by Acupuncture,' in which he relates several cases where the thrusting in of a needle in two or three places until the bone was touched, and leaving it there for a minute or two, was followed by complete cure in one instance, and relief in three or four more out of ten cases, and explains his view of the mode of action. Also Mr. Simeon Snell, of Sheffield, in the *Medical Times and Gazette* (June 9, 1880), relates several cases of loss of power of the deltoid, which he treated successfully in the same manner. Acupuncture has been used in the treatment of ununited fractures. Here the object is to set up irritation and increased vascularity, and the needles should be left in for several days. In a case related by Wiesel (mentioned in Holmes' *System of Surgery*), they were left in for six days, until they caused pain and swelling, and the result was successful. Malgaigne tried this plan, but unsuccessfully. The difficulty is to get the needles between the ends of the bone.

Lastly, acupuncture has been tried in the treatment of aneurism. Originally suggested by Velpeau, it was practised with a successful result by Benjamin Phillips, of London, in 1831, in a case of carotid aneurism. In more recent times (January 1879), it was tried by Mr. Christopher Heath, in a case of traumatic aneurism of the subclavian, where amputation at the shoulder-joint had failed. He 'introduced three pairs of sewing needles into the tumour, making each pair cross within the sac; they were not withdrawn until the fifth day, by which time considerable clotting had taken place.' The aneurism gradually became solid; but bronchitis supervened, and the patient sank seventeen days after the insertion of the needles. The post-mortem examination showed that the aneurism was cured, the sac being full of dense fibrin. Encouraged by the result in this case, the writer of this article tried the same plan in a case of aneurism at the root of the neck, occurring in a man thirty-three years of age, who was under his care in the Liverpool Northern Hospital, in the early part of 1880. Mr. Heath's plan was as nearly as possible carried out accurately; but as there was no apparent effect at the end of four or five days, other needles were inserted, as the first were withdrawn, but at different parts of the swelling. As each needle was withdrawn, a few drops of blood escaped from the puncture, which was at once covered with styptic colloid. This procedure was carried out for several weeks, with the result that the tumour became firmer and the pulsation feebler; then the aneurism became smaller, and finally almost disappeared behind the sternal end of the clavicle. Unfortunately, some chronic cellulitis had been set up by the needles, and just at the time when success seemed to have been attained, a slight sanio-purulent discharge occurred from one of the needle-holes which reopened. The same evening the temperature rose, vomiting occurred (evidently due to septicæmia), and as a result of the vomiting the sac must have given way, for the swelling suddenly became diffuse, and several of the needle-punctures reopened, giving vent to broken-down clot and fresh arterial blood, and, in the course of less than forty-eight hours after, the patient died. A post-mortem examination revealed an aneurism of the innominate artery, the collapsed sac of which would have contained a small hen's egg; this sac had evidently recently given way, and the aneurism had become diffuse, forming a large cavity in the lower part of the neck containing fluid blood, fresh clots, and one large mass of old and thoroughly organised hard clot which had obviously filled the true aneurism, and escaped when the rupture of the sac occurred. This case, together with Mr. Heath's, may be taken as evidence that acupuncture is worthy of consideration in suitable cases of aneurism; but the writer feels that his own case is furthermore a warning against pushing this treatment too far. It would be better to wait patiently the result of the first introduction of the needles before proceeding to insert others.

Acupuncture has also been used in the treatment of cirsoid aneurism, but as in most instances it has been tried in combination with the galvanic current, its use in such cases can hardly be considered here, although Professor Billroth, its principal advocate, attributes the success in his three cases of galvano-puncture to the acupuncture only. CHAUNCY PUZEY.

ADAMS'S OPERATION.—An operation for the subcutaneous division of the neck of the femur in cases of angular osseous ankylosis of the hip-joint. *See* HIP-DISEASE.

ADENIA. *See* LYMPHADENOMA.

ADENITIS. *See* LYMPHADENITIS.

ADENOMA.—An adenoma is an encapsuled tumour, containing in its structure the textures found in glands, and commonly those of a racemose gland, and it generally occupies a position on the periphery of one of the complex secreting glands, the mammary region being by far the most frequent site of adenomatous growths. Some of the prostatic enlargements are tumours of this kind, and occasionally they are found in the lips and cheeks. The parotid is a common position, but here adenomata not infrequently contain cartilage, as also do those which less frequently occur in the sub-maxillary region.

Cause.—No cause capable of demonstration can be assigned for the occurrence of adenomata. It has been suggested, from the circumstance of such tumours appearing, or rather taking on growth, during the period of functional activity in the adjacent gland, that they are congenital, having remained dormant during early life. Some force is lent to this suggestion by the fact that some of the mammary adenomata shrink and seem to disappear with the occurrence of atrophic changes in the mammary gland itself.

Pathology.—For a tumour growing in proximity to a gland to be regarded as an adenoma, it must possess the histological characters of gland-structure, and usually, as has been noticed, that of a racemose gland, with its grouping of acini, tubules, and lobules. *See* BREAST, Diseases of the.

Symptoms and Diagnosis.—These vary so entirely with the situation of the adenoma, that it is an impossibility to give any general description of the external characters of this class of tumour which should hold good for chronic mammary tumours, for an adenoma of the lip, or of the encysted tumours of the prostate. As the mammary region supplies the greater number of gland-tumours, a description of one of these will indicate the clinical features of adenoma sufficiently.

In size adenomata vary from a hazel-nut to a walnut, and are usually found in young unmarried women; they are rare after the age of forty. They are usually firm and irregularly ovoid; they do not adhere to the skin, or cause dimpling of it. They are very freely movable, but nevertheless are seemingly attached to the adjacent mammary gland. Sometimes they are contained within the substance of the gland, or cause a depression on its surface, and they rarely afford any feeling of fluid. When pain is complained of, it is usually paroxysmal or neuralgic, and there is frequently complaint of some increased fulness and tenderness at the menstrual periods. Often they remain stationary for years, and then enlarge, or with disappearance of the menstrual flux they may shrivel.

As a rule, the *diagnosis* is easy. A limited isolated tumour, not very hard and without lymphatic affection, can scarcely be taken for a carcinoma. Rarely is the sense of fluctuation obtained, but a quickly-growing adenoma in the substance of the breast may be mistaken for some one of the cyst-formations found in this organ. So, again, it may not be possible to tell before removal whether a tumour is a quickly-growing adenoma or a sarcoma.

In later life, however, it is not always easy by examination alone to say whether a firm swelling is an adenoma or a small circumscribed scirrhus-growth of a portion of the margin of the gland. Due attention to the duration, the age, and the history, will generally enable a correct diagnosis to be made.

Treatment.—If decidedly increasing in size, if disfiguring, if the pain is so great as to cause distress to the patient, or if the mental anxiety at discovering a tumour in the breast affects the health, it will be well to advise the removal of an adenoma. On the other hand, in the absence of any of these circumstances, the patient may be told that the growth is quite innocent in its nature, and that, so long as it is not a source of annoyance, there is no object to be gained by an operation. In these cases, and in others where the patient shrinks from an operation which the surgeon can seldom truthfully say is imperatively demanded, much relief may be obtained by insisting on the abandonment of all such dresses or other garments as press upon the tumour, and by protecting the part from ever-repeated self-examinations of the swelling, which only irritate the part and disquiet the mind; nothing answers this purpose better than a belladonna plaster, kept on for two or three weeks. Temporary restraint of the use of the arm by the adoption of a sling may be advised when there is shooting pain, referred, it is to be presumed, to the inner side of the arm. The patient should be strongly urged to dismiss all thoughts of the swelling from her mind. Of course, many points in the patient's general health may need attention, and signs of indigestion, habitual constipation, irregular, scanty, and painful menstruation, should be at once attended to. A. Willett.

ADHESION.—The growing together of living tissues, healthy or diseased. Physiological adhesion is the basis of reparative surgery; pathological adhesion is one of the most fertile and potent factors in the development of surgical complications.

Healthy adhesion of divided tissues is the continuous work of normal nutrition, commencing so soon as divided surfaces or parts are restored to, and maintained in, accurate contact. As divided parts approach most nearly to the state of health, their reunion is proportionately rapid, painless, and firm. Foreign bodies and impurities, tension and unrest, are causes of nervous and vascular irritation; and, to an equal extent, impediments to direct adhesion. This is illustrated in all the operations of plastic surgery, and generally in the healing of wounds, whether of the soft or hard parts. *See* Fractures; Wounds.

When the physiological standard is departed from, and excess of vascular and nutritive activity reaches the inflammatory stage, adhesion may still occur; and often does so, under those circumstances, to a very great extent. But adhesive inflammation is strictly a pathological process, and a cause of diseased conditions. Cicatrices, when adherent to subjacent parts, and especially to bone after amputation, are often causes of lifelong trouble. Injuries into, and in the neighbourhood of, joints, are followed by impairment of motion, in proportion as synovial membranes and tendinous sheaths become adherent. Bands and layers of lymph deposited within the abdomen are frequent causes of internal strangulation, and serious complications of ovarian and uterine disease. The ophthalmic surgeon also has abundant evidence of the mischief worked within the eye by pathological adhesion.

Nevertheless, the process of adhesion surpassing the physiological limits often has a preservative tendency, which the surgeon may utilise with the best results. Bullets and other foreign bodies which sometimes remain painlessly within the body for years, do so in virtue of the inflammatory process which they excite, and the adhesive products therefrom resulting. Internal abscess, aneurism, phlebitis, and ulceration may be rendered comparatively harmless by inflammatory adhesions. In arresting hæmorrhage from divided arteries, in treating intestinal wounds, in the radical cure of hernia, hydrocele, nævus, and varix, the surgeon relies on his power to produce inflammation, within the limits of adhesion. So directed and restricted, inflammatory adhesion is a therapeutic resource, often as beneficent and enduring as is painless and physiological adhesion.

Sampson Gamgee.

AINHUM.—This disease occurs in negroes, especially those of Brazil and Bahia. It affects the little toes chiefly, and appears to consist in a fatty degeneration of all the tissues, commencing without pain, and not affecting the general health. A groove gradually extends round the root of the toe; the parts beyond this are much increased in size, become looser and looser, and interfere with walking.

Treatment.—Amputation.

W. H. A. Jacobson.

AIR IN CELLULAR TISSUE. *See* Emphysema.

AIR IN VEINS.—*Pathology.*—The entrance of air into veins through a wound in their parietes is an exceedingly grave accident. The occurrence may give rise to a train of the most serious symptoms, or may lead to an almost sudden death. The air is drawn into the thorax through the wound in the vein by the inspiratory movement of the chest, just as it is drawn into the lung through the trachea. It enters the right auricle of the heart, and that cavity, after death, will be found to be quite distended by a frothy mixture of blood and air. The same froth will be found in the superior vena cava and the innominate veins. The air may make its way into the right ventricle, and a small quantity may even penetrate as far as the pulmonary artery and its branches. Death in these cases appears to be due to arrest of the pulmonary circulation and to interference with the heart's mechanism. For the proper working of the tricuspid and pulmonary valves it is necessary that the heart should be occupied by fluid blood. The valves cannot act in a mixture of air and blood, and with the cessation of their action the proper movement of the heart ceases. The circulation of blood through the lungs must be suddenly interrupted when this accident occurs, and as but little blood can reach the left ventricle, anæmia of the brain and of other parts must be produced.

The aspiratory effect of the thorax upon the venous circulation does not appear to extend beyond the vessels of the neck and axilla. The isolated cases, in which air is said to have been drawn into the thorax through wounds in such veins as the median basilic and the long saphenous, are open to considerable doubt. The cervical veins have been much more frequently the seat of this accident than the veins of the axilla.

That air may enter it is necessary that the vein be only partly divided, or, if entirely divided, that its lumen be kept open by the adhesion of the vein-walls to the adjacent parts. If a normal vein in the regions in question be entirely cut across, its limp walls are drawn together during an inspiratory movement and its lumen is more or less entirely closed. This closure is really effected by atmospheric pressure, and can be well seen in drawing air along a thin india-rubber tube, a part of whose wall has been divided. Veins whose walls are thickened are apt to favour the entrance of air, as are also such vessels as are bound up in inflammatory material or in the substance of a new growth. The external jugular vein, moreover, is so related to the cervical fascia, and the axillary vein to the costo-coracoid membrane, that these vessels remain patent when cut across. Often the dragging upon the parts, as in removing a tumour, is such as to make some of the veins that have been divided gape and remain open. The accident has occurred most frequently during the removal of tumours from the neck or axilla. It has happened also during amputation at the shoulder, resection of the scapula, ligature of the carotid and subclavian arteries, tracheotomy, venesection of the external jugular vein, and, in one recorded instance, during the introduction of a seton in the neck.

Symptoms.—The entrance of the air is marked by a very distinct hissing noise, precisely like that heard when air and water are being drawn up by a syringe. It must be especially noted that if any bubbles are seen about the wound they are caused, not by the air that is entering, but by the air that has escaped from the vein during the expiratory movement of the thorax. The patient, if not anæsthetised, is seized with a sudden terror; there is severe dyspnœa with hurried and violent inspirations; the action of the heart becomes irregular and often tumultuous; the pulse sinks, is most irregular, and often becomes rapidly imperceptible; the face is, as a rule, bluish at first and then becomes pale; there is more or less profound syncope, and in some cases there may be convulsions of a tetanic character or a violent cough. The dyspnœa is probably entirely due to the sudden interruption in the pulmonary circulation, while the faintness depends mainly upon the anæmia of the brain consequent upon the lack of blood in the left ventricle. About two-thirds of the patients thus affected die, the majority within a few minutes, the remainder after an interval of hours or even days. On the other hand, recovery has taken place, even after the symptoms have been very severe, and in a few instances no visible ill-effects have followed the accident, although the hissing noise was distinctly heard. Clinical experience, as well as vivisection experiment, appears to show that the fatal result depends rather upon the rapidity with which the air is introduced than upon the actual amount that enters, other things being equal.

Treatment.—It cannot be too constantly borne in mind that this accident can only occur in what may be termed dry wounds. The injured vein must be either exposed to the air or separated from the air by only a thin layer of blood; if the wound be full of blood the accident is impossible. As may be supposed, it occurs most usually when a tumour is being dragged from its attachments, or just after a deep incision has been well sponged out.

The moment the hissing sound is heard the wound should be filled with water squeezed from a sponge. This at once prevents the entrance of more air, and at the most the patient merely draws into the vein a little blood and water. It is useless at the first to attempt to tie the vein. The damaged vessel is not easy to find, and to apply a ligature takes time. Moreover, if the ligature be applied during an inspiration, it would certainly prevent the entrance of more air, but if applied during an expiration it would merely prevent the escape of such air as had already entered. To place the finger upon the divided vein during inspiration and remove it during expiration would not be bad practice. But here again comes the difficulty of recognising the damaged vein. The hissing sound is the only guide. There is nothing to be seen as the air enters. Any bubbles that are seen in the wound indicate the escape of air, and to place the finger over the spot where the bubbles are seen—as some advise—would be obviously bad practice. The filling of the wound with water is a ready and safe expedient, and, in all deep operations about the neck and axilla, the writer always has a sponge filled with water held ready, so that in a moment its contents can be squeezed into the wound.

The second step in the treatment of the accident is to endeavour to remove the air that has already entered the chest. This can be best effected by waiting until the next expiratory movement, and then bringing forcible pressure to bear upon the front of the thorax. The air so expressed bubbles up through the water or blood that still fills the wound, and is obviously unable to re-enter so long as the wound is protected in the way indicated. The ease with which a large quantity of air can be expressed from the chest during an expiration is remarkable, and especially in children. The relief given to even the most alarming symptoms is immediate and striking. When all the air has been expressed, the wounded vein should be seized—most conveniently with a pair of Spencer Wells' forceps—and either entirely divided or ligatured. The writer has recorded two cases (*Brit. Med. Journ.* June 30, 1883) where the treatment just detailed was carried out with complete success. The suggestion that the air should be sucked out of the auricle through a catheter passed down one of the main veins cannot be too strongly condemned. An almost equally objectionable practice is that of resorting to artificial respiration. There is no lack of air in the thorax, but indeed too much, and this mode of treatment could only have the effect of hastening a fatal issue. FREDERICK TREVES.

ALBINISM.—The absence of pigment from those parts of the body ordinarily coloured, e.g. the skin, hairs, and iris. The subject of this congenital defect is ordinarily termed an ALBINO.

ALBUGO.—A dense white opacity of the cornea, generally resulting from injury, especially burns with caustic lime.

ALBUMINOID DEGENERATION is a variety of retrogressive metamorphosis of the albuminous constituents of animal protoplasm, almost invariably consequent upon the cachectic condition produced by some wasting disease. It most frequently attacks the arterioles and small blood-vessels, then the spleen, liver, lymph-glands, intestine, kidney, heart, and muscles, while very rarely only one organ may be notably affected.

Etiology and Causation.—This change which, when once begun, is almost invariably fatally progressive, attacks individuals usually between the ages of 10–30 years, and more frequently those of the second decade, namely, 20–30 years. Further, males suffer much more frequently than females, a striking difference which may possibly be accounted for by the greater prevalence of syphilis among the male sex.

It is usually preceded by, if not always caused by, one of the following diseases:—Prolonged suppuration, chronic lung-disease, accompanied by suppuration (namely phthisis, bronchiectasis, chronic bronchitis), leukæmia, rickets, gout, simple new-growths (e.g. myxofibroma, &c.), and the following cachectic states. Syphilis (not only with osteitis, but also in cases of syphiloderma, and in the congenital as well as the acquired form of the disease), intermittent fever, and mercurial poisoning.

The most favourably received explanation of the mode in which this change in the tissues may be brought about, is that of Dr. Dickinson, namely, that the albuminoid condition is the result of a constant drain from the body (by the suppurative discharge) of the alkaline salts, notably the compounds of potassium. This theory is supported by many histo-chemical facts and analogies, and therefore is given here in the absence of fuller knowledge on the point. The development of the change, usually supposed to be slow, was shown by Cohnheim to be occasionally very rapid; thus he found it very extensively marked within three months of the infliction of the lesion which started the degenerative process.

Symptoms. — The symptoms directly due to interference with the functions of the various organs affected, are fairly marked, so as to enable us to distinguish them from those due to concurrent affections.

From the fact of the disease attacking the organs and tissues in the order given above, the following are the most marked symptoms :—*anæmia*, affecting the red corpuscles mainly, is rather rapidly developed, and then remains almost at an equilibrium, but increases slightly towards death; *hydræmia*, causing œdema of many parts, more especially the connective tissues of the lower limbs, sometimes invades the whole body in advanced cases, when albuminuria reveals the fact that the afferent arterioles and malpighian glomeruli in the kidney are practically *hors de combat.* Occasionally *ascites* is present, the serous effusion being increased by pressure of the enlarged liver upon the portal vein. *Hæmorrhages* may occur, and death has followed directly from hæmatemesis. *Pseudo-leukæmia* is commonly noted as a combination of the foregoing symptoms. *Tumours* of the organs most frequently affected—viz. the liver and spleen—are easily discovered and recognised by their even surface and outline; *pain* is produced in the abdomen by a little local peritonitis around the affected organs, which are commonly found covered with adhesions. The *appetite* fails, and sometimes *vomiting* is noted; the *excreta* are pale from the absence of *bile*, stinking, covered with mucus, and followed by much flatulent discharge of gases. This change does not give rise to any pyrexia.

Diagnosis is rendered easy by observing the concurrence of the above symptoms with one of the diseases noted as leading to the degenerative change in the tissues.

Prognosis is probably always hopeless.

Pathological Anatomy.—The degeneration in an early stage is found to cause the intima or internal coat of the arterioles to become thickened, structureless, hyaline, and brightly refracting, while in addition Kyber noticed the arterioles to be frequently varicose. In other vessels the middle muscular coat becomes similarly affected; in the capillaries, as may be well seen in the malpighian glomeruli, the whole bunch of vessels becomes gradually fused into a bright amorphous mass. The veins almost escape the change altogether. This distribution of the degeneration is well illustrated by the disease as it occurs in the liver, where the middle zone of each hepatic lobule (namely, that part of it which is supplied by the hepatic artery more especially), is found to be first the seat of the change.

In consequence of the above changes in the blood-vessels, an organ which is thus degenerated appears on section to be bloodless, the surface being dry and pale; owing to the physical properties of the degeneration product, the whole organ is, as a rule, enlarged, has a bright shining surface on section, and while frequently hard, is yet tough and resistant to reagents, the mass not being soluble in either acid or alkaline solutions, and not readily decomposed.

The proper gland-cells of an organ thus diseased are said by some to be unaffected by the change directly, but to undergo fatty degeneration and atrophy as a result of the ischæmia produced by the disease of the blood-vessels; but in many instances they can be seen to be involved in the general metamorphosis which eventually converts the whole tissue into an amorphous refractive mass. Chemically this product has been isolated as lardacein, which is not amyloid or starchy as supposed by Virchow and others, but is an albuminous substance recognised most easily by its physical properties and its reaction to iodine and methyl anilin violet. Thus, if the cut surfaces of an affected organ be washed with water, and then (for some minutes), with a solution in water containing ·5 per cent. of iodine, and 1·5 per cent. of iodide of potassium, the diseased portions will be coloured of a mahogany red colour quite different to the general yellow stain of the surrounding parts; and if, moreover, a 10 per cent. solution of sulphuric acid be added, the red staining of the diseased tissues will change to a dirty purple or violet tinge. When the affected tissue is stained with methyl violet, the diseased portion becomes red and the healthy part blue.

Treatment. — This must of course be first directed to the removal of the cause if possible, and in the mean time to endeavour to relieve the organs chiefly attacked, while the general strength is being maintained. Thus constipation and diarrhœa, &c., must be treated by appropriate drugs; the skin, often harsh and dry, must be excited by hot air baths and pilocarpine, in order to relieve the kidneys; in fact, vicarious action must be encouraged as far as possible. At the same time free oxygenation of the tissues must be provided for by proper change of air, and the drain of potassium salts met by the administration of the same in combination with peptonised albumen, or some similar vehicle, which will admit of their being rapidly and easily assimilated. Iodide of iron and carbonate of ammonia have been much recommended, and can do no harm.

The diet must be chosen so that as far as possible the alimentary canal, the submucous coat of which is attacked early in the disease, may be relieved. This will best be effected by the food being of a light nature, and in addition being partly peptonised or pancreatised beforehand. The former is less disagreeable often to the patient, who of course is subject at any moment to attacks of vomiting and dyspepsia. VICTOR HORSLEY.

ALBUMINURIA.—The form of albumin which appears in the urine is nearly always serum albumin; egg albumin, and a peculiar variety described by Bence Jones from a case of osteomalacia, have also been found, but only under very exceptional conditions, and are of little surgical importance.

The albumin may be derived (1) from the mucous membrane lining the urethra in front of the compressor urethræ muscle; (2) from the prostatic portion of the urethra, the neck of the bladder, and the bladder itself; and (3) from the ureters and the pelves of the kidneys, and the kidneys themselves. Further, in the female, a very considerable quantity may find its way into the urine from the neighbouring genital organs, especially in cases of leucorrhœa; and even in the male it is probable that from time to time small quantities of spermatic secretion containing albumin may be discharged with the urine.

Albumin present in the urine, and derived from the anterior portion of the urethra, points to some inflammation of the mucous membrane, either gonorrhœal or else catarrhal, due to stricture, the presence of papillary granulations, some neighbouring inflammation, or even a constitutional affection—syphilis, struma, tubercle, or gout—roused into activity by some accidental cause. This may be distinguished by its always being small in quantity, and by the fact that it is only present in the first portion of the urine passed; the urethra is washed clear by the stream flowing through, and if care is taken to keep the first ounce separate, the rest will be found free. Not infrequently, under these conditions, there are found in the urine long, semi-transparent, rolled-up threads, the so-called gonorrhœal casts.

The portion of the urethra lying behind the compressor urethræ muscle, belongs, surgically speaking, to the neck of the bladder; if a large amount of secretion collects anteriorly to this point, it flows out of the meatus urinarius, and is known as a gleet; if posteriorly, it flows back into the bladder, and becomes mixed with the urine. Under these circumstances, though the first portion of the urine passed contains the largest amount of albumin, and, perhaps, casts of the prostatic ducts and spermatozoa, the rest is not quite free; and, in addition, there are the ordinary symptoms of inflammation about the neck of the bladder—frequent micturition, strangury, especially at the end of micturition, pain in the perinæum, and, perhaps, just at the close, when the bladder is contracting, a few drops of blood.

If the source of the albumin is the mucous lining of the bladder itself, it is very rare for the urine not to show other changes in reaction, deposit, and microscopic characters. There may only be a slight cloud floating about, with a few mucous corpuscles and detached epithelial cells visible under the microscope; or the urine may be foul and offensive, alkaline, partly from the amount of alkaline mucus added, partly from the decomposition of urea, with a thick, dense, gelatinous deposit of muco-pus mixed with triple phosphate crystals forming slowly at the bottom of the vessel, and, when this is inverted, falling out in a tenacious slimy mass.

It occasionally happens that this deposit of muco-purulent matter occurs in acid urine, of course unmixed then with crystals; no casts can be found; the urine remains acid, in spite of the large amount of alkaline mucus added; frequent micturition may be present, because the urine is no longer in normal relation with the bladder, but there is no strangury, showing that the neck of the bladder is not inflamed. Under these conditions it is to be suspected that the pus may come from the pelvis of the kidney, and that not improbably the whole of that organ may be disorganised, and consist of nothing but a greasy, yellowish-white, tenacious mass, enclosed by the capsule, on the inner side of which some shreds of cortex may still persist—strumous pyelitis.

Calculous pyelitis, and surgical kidney causing albuminuria, may be, in general, distinguished by the other changes that take place in the urine simultaneously, the occasional presence of blood, the altered reaction, the amount of albumin, and the presence of tube-casts, showing that the secreting structure of the kidney itself is involved.

Albuminuria, further, is nearly always present, and is of very great surgical importance, in organic disease of the kidneys—amyloid, large, white, or the small contracted granular form—and the diagnosis must be made from a consideration of the cause, from the amount of urine passed, the specific gravity, the evidence of amyloid disease elsewhere, the condition of the organs of circulation, and the presence and character of the tube-casts.

Besides these causes, albumin may make its appearance in the urine from disturbance of the circulation through the kidney, not merely from passive congestion, as in heart-disease, but probably through interference with the vaso-motor nerves. At least, it seems most easy in this way to explain the occasional occurrence of albuminuria and even hæmaturia after injuries to the head or the spine, and after the administration of certain drugs. Whether there can be any connection between these facts and the frequency of renal degeneration in patients suffering from abdominal tumours, is uncertain.

Albuminuria, then, is to be regarded as a symptom indicative either of some abnormal condition of the genito-urinary tract, or of some alteration in the composition of the blood, and a diagnosis must be made of the cause of its appearance from its character and quantity, and from the other features presented by the urine. When it has gone on for any length of time, no matter what the cause, it is always of very serious import in prognosis; the general nutrition suffers in direct proportion to the amount of the loss, and anæmia, emaciation, weakness, and inability to resist depressing agencies, increase *pari passu*. This is to be regarded as of no less importance in renal disease than the defective elimination of effete material; in genuine contracting disease of the kidney, with little loss of albumin, the normal colour and plumpness are long retained.

Albuminuria is of such importance with regard to surgical operations, that it should be held as a rule from which no deviation is to be allowed, that the patient's urine should always be tested on the morning of an operation, and, if possible, several times before. Nor should the urine passed on rising only be made use of—the urina sanguinis—but that also which is passed at intervals throughout the twenty-four hours. If the albumin is a mere accidental admixture from the neighbouring genital organs, or if it comes from the urethra or neck of the bladder, and the operation is one devised for the purpose of removing the cause, of course it has little to do with the question of prognosis. But if it points to the presence of cystitis, or, even worse, disease of the kidneys, at once it becomes an exceedingly serious element. This is true, not only of the presence of albumin in the urine, but also if the specific gravity is low and the urea percentage habitually below normal. The writer has more than once seen patients whose urine presented these two conditions without albumin being present, suddenly, after an operation, excrete a large quantity, probably owing to a certain amount of fever.

Operations, in general, are affected, as regards prognosis, in two ways. In the first place, there is a very considerable loss of strength represented by the loss of so much albumin; and, secondly, if of any severity, a great amount of strain is thrown on organs already partly incapacitated by the extra quantity of waste developed in the system. But besides these two conditions, both of which are sufficiently serious, the genito-urinary tracts are so closely bound up with the kidneys by means of the nervous system, that if the latter are diseased it is highly probable that any operation on the former, even the passing of a catheter, will cause partial, or even complete, suppression of urine. This, in all probability, arises from congestion being set up in inflamed organs which are only just able to do their work under normal conditions, and is effected in some reflex manner through the nervous system.

Albuminuria, arising from amyloid disease of the kidneys, is, in some respects, peculiar. It may usually be diagnosed by the early occurrence of polyuria, and by the presence of waxy degeneration of other organs; and there can be no question that there is a possibility, if not of complete recovery, at least of cessation of progress of the disease, if the exciting cause of the amyloid change be removed sufficiently early. *See* URINE; UREA.

C. MANSELL MOULLIN.

ALKALIES, Swallowing of.—The caustic alkalies are not so frequently swallowed as are the acids. Potash, soda, and ammonia have each proved fatal. Like the acids, the danger depends more upon the concentration than the actual amount taken. The symptoms are those of a corrosive poison—abdominal pain, vomiting, thirst, followed by collapse. The vomit is alkaline, and is often soapy in character, with much ropy mucus. Perforation of the stomach is not so common as with the corrosive acids, but, nevertheless, may occur. The liquor potassæ of the Pharmacopœia has been taken by mistake, but the most common accident has been the swallowing of soap-lees by those employed in soap-works.

The *treatment* consists in the neutralisation of the alkali by the administration of dilute acids, vinegar, very dilute mineral acids, or citric or tartaric if these be not at hand. The juice of acid fruits, such as lemons, or even oranges, if given in large quantities, may be of service. The employment of the stomach-pump is not advisable, owing to the danger of perforating the softened mucous membrane. It may be advisable to give stimulants per rectum. Death may result at a more remote period from inanition, owing to the destruction of the glandular surface of the stomach, or by the occurrence of stricture of the œsophagus from contraction of the cicatrix, which is the result of the corrosion.

If the alkaline corrosives enter the air-passages, death may result (as with the acids) from suffocation.

The volatile alkali (ammonia), like the volatile acid, is very apt to affect the air-passages, owing to the inhalation of the caustic vapour, and in this case the patient dies from capillary bronchitis, with some patches of pneumonia. Ammonia sometimes has the effect of producing a false membrane on the trachea and bronchial tubes, which to the naked eye is indistinguishable from a diphtheritic membrane. Cases are on record of death being caused (in persons already much enfeebled) by the mere inhalation of ammoniacal vapour, owing to the incautious use of the strong ammoniacal solution as a 'smelling-salt' for restorative purposes. G. V. Poore.

ALLARTON'S OPERATION. — A modern form of median lithotomy. *See* Lithotomy.

ALOPECIA AREATA.—*Definition.*—Alopecia areata is a non-contagious atrophic disease of the hair, a chief feature of which is the rapid formation of smooth bald patches on the scalp or other hairy parts of the body.

Symptoms.—Although alopecia areata is chiefly met with on the scalp, yet it is not uncommon on the eyebrows and beard. In extreme cases the whole body is affected, and becomes completely denuded of hair. The disease is sometimes unilateral, but more frequently it is roughly symmetrical. The regions of the scalp most often affected are the lower occipital, where the scalp joins the skin of the neck, and the part behind the ears. The eyebrows are often shed, and when this is the case, the outer part generally goes first. The parts attacked are usually quite denuded of hair, with the exception perhaps of the margin, where a few stumps may sometimes be found. This abrupt contrast between the smooth white bald patch and surrounding luxuriant hair, gives to the disease its peculiar and characteristic appearance. In an early stage of the malady, the bald patch is sometimes pinker than the surrounding skin, but much more commonly it is of the same colour or paler. A loss of sensibility over the patch is rare, yet sufficiently common to have been noted by many observers. In most cases there is a complete absence of subjective sensations; in some, however, there is neuralgic pain, and in others a tenderness on pressure. One of the most remarkable features of the disease is its almost sudden onset without any very apparent cause. It is very chronic, often lasting for years, and is also very apt to recur, so that it is not uncommon to find adult patients suffering from their second, third, or even fourth attack.

Etiology and Pathology.—The causes of area are at present unknown. It is more common in the young than in the old, and is probably equally common in males and females. It is met with more frequently in England than on the continent of Europe. The belief in the parasitic origin of the disease has been completely abandoned by all competent observers, partly because the clinical features of the disease cannot be explained on this supposition, but still more from the fact that no one has been able to demonstrate the parasite under the microscope. The origin of the disease is probably due to nerve-disturbance, causing impaired nutrition and subsequent atrophy of the roots of the hairs, and sometimes also of the skin itself.

Diagnosis.—The only disease with which alopecia areata is confounded is tinea tonsurans. In doubtful cases the examination of the stumpy hairs under the microscope, will generally determine the point. There are, however, some instances of tinea tonsurans in which the diseased patches rapidly become bald and assume the appearance of alopecia areata; this change sometimes occurs naturally, and at other times is the result of treatment; in either case the differential diagnosis may be difficult, unless the history of the case is carefully investigated.

Treatment. — The treatment of this disease is not very satisfactory. Tonics, good food, and change of air are beneficial. Local remedies consist in stimulating lotions, the best of which are the various preparations of cantharides, especially the acetum cantharidis diluted with spirits of wine. It is, on the whole, better to use a preparation not quite strong enough to blister, so that it may be applied daily.

Robert Liveing.

ALTERNATING CALCULUS. *See* Calculus, Urinary.

ALVEOLAR ABSCESS occurs in both jaws, as the result of inflammation connected with the teeth and originating in the socket. The earliest symptom is pain, with slight protrusion of the tooth, due to the inflamed condition of the membranes covering the tooth and lining the alveolus. If not relieved by judicious leeching or incision, matter forms in the socket, and either finds its way out by the side of the tooth, which is necessarily loosened, or, after causing great pain for a day or two, perforates the alveolus, and finds its way beneath the gum. This is the ordinary form of 'gum-boil,' which breaks spontaneously and after causing much suffering, unless previously relieved by a timely incision or extraction of the tooth.

The propriety of an early and free incision through the gum on to the alveolus is to be strongly insisted on, since necrosis and consequent exfoliation of large portions of the jaw not unfrequently follow neglect or postponement of the operation. Extraction of the tooth alone is not sufficient where the alveolus has been perforated, and in many cases the incision will serve to preserve a useful, though dead, tooth for many years. A wound of the facial artery has been met with from the edge of the knife being turned towards the soft tissues instead of against the alveolus.

But alveolar abscess does not always point within the mouth. The perforation of the alveolus may take place beyond the line of reflection of the buccal mucous membrane, and then the matter has to find its way to the nearest skin. In this way abscesses, with their resulting fistulæ, may be seen on any part of the face or neck, and occasionally grave errors of diagnosis are made from non-recognition of the fact that alveolar abscesses may burrow for long distances. The writer has known one instance of fatal suppuration between the muscles of the neck, leading eventually to suffocation, due entirely to mischief around a molar tooth in a patient whose health was undermined by drink.

In the case of the upper jaw, abscess connected with the incisor teeth not unfrequently finds its way backwards along the hard palate, and occasionally, but more rarely, into the nostril, being then liable to be mistaken for discharge from the nose itself or from the antrum.

Christopher Heath.

ALVEOLAR CANCER.—A term applied to colloid cancer. *See* Carcinoma.

ALVEOLAR SARCOMA. *See* Sarcoma.

ALVEOLUS, Fracture of the.—This is a frequent accompaniment of tooth-extraction even in the most skilful hands, and depends for the most part upon the divergence of the fangs of the teeth, by which extraction is rendered difficult. The operator may or may not be conscious that the alveolus is yielding to the pressure of the forceps, but upon the extraction of the tooth finds a portion of the outer plate of the alveolus loose beneath the gum. This need give rise to no uneasiness unless very extensive, since reunion of the fragment often takes place readily, or, at the worst, the portion detached becomes necrosed and exfoliates in the ordinary way. It is well to press together the margins of the alveolus in all cases of extraction, but when a distinct fracture has occurred caution must be used lest the fragment should be forced through the gum.

Christopher Heath.

AMAUROSIS.—The term amaurosis was formerly applied to all those cases in which the patient complained of complete loss of vision, whilst there was no apparent disease of the eye except that the pupil was dilated and remained motionless under the stimulus of light. It was synonymous therefore, in a large number of cases, with what is now called white atrophy of the optic nerve with cupping of the disk, which is most frequently the sequel of glaucoma; but other conditions were included in it, so that upwards of thirty varieties, distinguished by their real or supposed origin, or by some associated symptoms, were admitted and described by the older authors. Yet in some modern works upon the eye the term amaurosis is hardly so much as mentioned;

no chapter is devoted to its consideration, and most of the diseases once included in it, being easily recognised and discriminated from each other by the practised eye, are now discussed under separate headings. The uncertainty attached to its meaning has frequently led to its employment with the addition of some qualifying epithet, such as 'complete' or 'partial,' or 'unilateral' or 'hemianopic,' but it is properly restricted at the present time to those cases of total blindness which are associated with atrophy of the optic nerve without cupping of the disk, and to those cases of loss of vision in which the most careful examination, with all the advantages resulting from improved methods of research, fail to reveal any physical changes in the media or tunics of the eye. In all instances the function of the retina and optic nerve must be entirely abolished, or the case becomes one of mere dulness of vision, the causes and varieties of which will be considered under the head of AMBLYOPIA.

Etiology.—If a typical case of amaurosis be placed before the ophthalmic surgeon—one, that is to say, in which there is total loss of vision whilst the optic disk is of a dead white colour—and he is asked what may have led to this condition, many causes present themselves to his mind. Amongst these are surgical injuries, such as contusions of the eyes from blows with balls, champagne or soda-water corks; lesions of the globe or of the optic nerves, tracts, and centres from the entrance of foreign bodies, as in gunshot wounds; compression of the nerve in the optic foramen, owing to fracture of the bone or to periostitis; or similar pressure exerted by effusions of lymph, blood, or pus, as in the atrophy that occurs after capsulitis and inflammation of the cellular tissue of the orbit, which may be either primary or an extension of erysipelas of the face. Pressure on the nerve may also be exerted by thrombosis and by aneurism of some branch of the ophthalmic artery, or the nerve may receive an insufficient supply of nourishment owing to embolism of the arteria centralis retinæ; or there may be disease of the central nervous apparatus affecting the corpora quadrigemina, optic thalamus, cortex cerebri, or spinal cord. Again, meningitis, congenital malformation of the skull and hyperostosis, or imperfect development of the brain may be present.

Amaurosis may also be the result of causes affecting the metabolism of the system generally and of the nervous system in particular, as in the cases which follow typhus, scarlet fever, diphtheria, or other exanthem. It may be a symptom of Bright's disease, or proceed from the administration of large doses of quinine, or from the abuse of alcohol or tobacco, or from exposure to the injurious action of lead; from sexual excesses, or—which is perhaps of most common occurrence—proceed from syphilis. It has been known to follow the suppression of habitual discharges and the sudden arrest of the catamenia, and many instances have been recorded of its occurrence as a symptom of hysteria and of epilepsy. It has occasionally been observed to arise from reflex irritation, as in dental disease, especially when inducing suppuration in the antrum of Highmore, from worms in the alimentary canal, and from comparatively slight blows causing lesion of the branches of the fifth pair of nerves distributed to the brow, face, and temple.

In regard to this last point, without denying that a contusion of the supraorbital nerves, or their division and subsequent implication in the cicatrix, might lead to reflex amaurosis, it may safely be stated that some of the recorded cases, if they had been examined by means of the ophthalmoscope, would have exhibited visible lesions sufficient to account for the sudden accession of blindness, such, for example, as hæmorrhage into the vitreous, or detachment of the retina; or in cases where the onset of the disease was slower, progressive white atrophy with or without optic neuritis.

Lastly, amaurosis sometimes only temporary but at other times persistent, has been noted as a result of severe hæmorrhages.

The conditions which may lead to amaurosis are thus seen to be sufficiently numerous and diverse, and there are still other cases, of the cause of which no satisfactory explanation can be afforded. It is probable, however, that the history of the case, with a careful consideration of the collateral symptoms, especially of those presented by the nervo-muscular apparatus, will, in most instances, enable the locality, if not the precise nature, of the primary affection to be determined with some approach to precision, even in cases where the exterior of the eye appears to be normal.

Some of the forms of amaurosis mentioned above are very slow in their progress, and, as in the case of alcoholic and tobacco amaurosis, rarely proceed to complete loss of vision, so that their description is relegated to the article AMBLYOPIA.

Symptoms.—The symptoms in a typical case of amaurosis may be divided into the objective and the subjective. The objective symptoms are the dilatation, not generally extreme, of the pupil, with immobility of the iris when light falls suddenly and directly upon the eye. It is well to note, however, that if the amaurosis be unilateral, associated movements of contraction and dilatation may sometimes be observed in the affected eye when the sound one is exposed to the alternate play of light and shade, and that contraction may also occur as an associated movement when the eyes are made to converge in accommodation—a condition, sometimes termed the Argyll-Robertson symptom, from that surgeon having first noticed its occurrence. The eyes are often otherwise natural in brightness, in size, in form, in colour, and even in their tension, though this is generally and sometimes considerably increased; and in the earlier periods of the disease, whatever may be its origin, they may move symmetrically.

The gait of the patient, and the expression, or rather absence of expression, in the face, are characteristic. The head is carried erect, and the elevated eyes seem as it were to search for light, in marked contrast to the lowered head, shaded eyes, and cautious step of the cataractous patient. The eyes gazing into vacancy, with their visual axes parallel, present a persistent unmeaning stare, which is well known and cannot be easily imitated. Oblique illumination reveals nothing except the immobility of the pupil and the absence of any reflex movements of the lids when a strong light is thrown upon the eye. Ophthalmoscopic examination demonstrates, in the great majority of cases, that the media are clear, and that the choroid and retina present little or no indication of disease. The only part which has undergone conspicuous change is the optic papilla, though in some cases even this is unaltered. Usually, however, it is seen to be well-defined at the margins, and, of various degrees of whiteness, from a pallor that is within physiological limits to an intense porcelanous or bluish whiteness. The retinal vessels are sometimes small, straight, attenuated, and greatly reduced in number, whilst at others they preserve almost their natural size and characters. In some instances, indications of optic neuritis and retinal and choroidal changes may be seen in the immediate vicinity of the disk.

The subjective symptoms are—loss of vision, freedom from pain, and an incapacity of the retina to respond to any stimulus—luminous, mechanical, or electrical. Hence the brightest illumination, such as exposure to the sun, fails to awaken any sensation of light; and none of those luminous rings can be perceived, which are produced in the healthy eye by pressure on the globe, and which have received the name of phosphenes.

Treatment.—In regard to the treatment of amaurosis, much must depend upon the sagacity of the surgeon in discovering its cause. The numerous remedies which were formerly recommended as a consequence of the ignorance which prevailed in regard to the etiology of the disease and the physical conditions that were present, have successively fallen into disrepute, and their ill-directed use in pre-ophthalmoscopic times has given place to an apathy which neglects all means of cure. Yet it is possible that in some cases, especially in those which occur after fevers, the administration of appropriate remedies might be attended with improvement if not with perfect restoration of vision. It is certain that the most complete white atrophy does not preclude the possession of a very considerable amount of vision, and no forecast can therefore be founded upon this symptom alone. As a rule the employment of strychnia may be recommended, which may be administered in doses of ten minims of the solution, or it may be subcutaneously injected in quantities commencing with one-twenty-fifth of a grain daily or three times a week, rising gradually to one-tenth of a grain, repeated with equal or greater frequency. Larger doses are not in general well borne, the patients complaining of giddiness and twitchings of the muscles. Iron may with advantage be conjoined with the strychnia, and when these remedies fail, sulphate of zinc or of copper in doses of from one-quarter to one grain. Arsenic in ordinary doses, and gold cyanide in doses of one-eighteenth grain, may be given. As a rule iodide of potassium and mercury, in any mode of administration, are without effect, and indeed, when vision is not wholly abolished, appear, by depressing the patient, to do more harm than good. When white atrophy is fully established, the time for their employment is past. The same may be said of all local depletory measures, such as leeches, blisters, setons, and issues. The general health should be attended to, good diet prescribed, and attention to the bowels enjoined, and the respiratory and circulatory functions promoted by baths, exercise, and change of air. Without going so far as to state that electricity, whether employed in the form of the constant or of the interrupted current, is never successful, it may fairly be said that it has been often tried and has often failed. If employed it will be found that the constant current is more effective than the interrupted.

For Simulated Amaurosis *see* Vision, Feigned Disorders of. Henry Power.

AMAZIA, or Complete Absence of the Mamma, is very rare. It has usually been associated with absence or imperfect development of the pectoralis major, and sometimes of some of the ribs on the side on which the gland was wanting. A rudimentary condition of the breast in the female, resembling that of the male, has been met with in conjunction with congenital absence of the ovaries.

Marcus Beck.

AMBLYOPIA.—The term amblyopia signifies dimness, dulness, or indistinctness of vision, a condition that may arise from many causes. In the first place the media may be cloudy, preventing more or less completely the access of light to the retina. Secondly, although the media may be clear, their refractive power may be at fault; parallel rays of light when the eye is at rest being brought to a focus in front of the retina, as in myopia; behind it, as in hypermetropia; or meeting in different foci in different meridians, as in astigmatism; in each case causing the image formed on the retina to be blurred and indistinct. Thirdly, although the image is perfectly well defined on the retina, this organ may, as the result of some structural defect proceeding from imperfect development, inflammation, non-use, or other cause, be unable to convert luminous waves into nervous impulses, and even if such conversion occur, the optic nerves and tracts may be incapable of transmitting the impulses generated to the brain. Lastly, although all conditions requisite for clear vision may, so far as the eye is concerned, exist, the central nervous apparatus may be the seat of some lesion that renders it incapable of appreciating and responding to the impressions transmitted to it by the optic nerves. Each of these forms of amblyopia requires brief consideration.

In England there do not appear to be any precise instructions issued to guide the examiners in determining what degree of impairment of vision should exist to cause rejection for the naval and military services; but in France, M. Barthélemy states that for admission into the army a recruit must see $\frac{25}{100}$, or $\frac{1}{4}$th the normal, with the right eye, and $\frac{8\cdot5}{100}$, or $\frac{1}{12}$th, with the left eye, whilst for the inscription or for the marines it must be $\frac{50}{100}$ at least.

This is not altogether an arbitrary limit, but is in relation with the ordinary conditions of military life; for it is clearly essential that, as M. Barthélemy observes, a soldier should be able to distinguish a sentinel, a man on horseback, a group of men, count the files of a squadron, judge of their state of repose or movement, their line of march, and the like, at a distance of at least 250 to 300 yards. He must be able to take effective aim at about the same distance, but the body of a man having a height of 5 feet, and a breadth of 12 to 15 inches, is easily distinguished at a distance of from 1,200 to 1,400 yards by a normal eye, and would therefore be still seen at 300 yards by an eye that had lost three-fourths of its visual power, at a distance at which the fire of a rifleman is highly effective.

For amblyopia due to cloudy media and diseases of the optic nerve and retina, see articles Cornea; Crystalline Lens; Vitreous, Diseases of the; Optic Nerve; Retina, Affections of the; Choroid, Diseases of the.

Amblyopia ex Anopsia is a term that has been applied to those cases where the dimness of vision is simply the result of disuse. This condition is familiar to ophthalmic surgeons in cases of squint, but is also observed in cases of congenital cataract, of leucoma, and of other affections in which the access of light is prevented or interfered with. In those cases of squint where the only defect is some error of refraction, the images of external objects, when the affected eye is at rest, are dim and indistinct, and little attention is paid to them, and if, as in hypermetropia, clear vision can only be obtained by a strong effort of the accommodative power for a short time, the internal recti soon become fatigued, the convergence of the eyes can no longer be maintained, and one eye wanders from the point of fixation. In some instances the patient uses the eyes alternately, and then good vision may be preserved in both; but in many cases a preference is given to one eye; the impressions made upon the other are then less and less attended to, and finally, in a few rare cases, the torpor or inactivity of the receptive apparatus in the eye, or of the percipient cells in the brain, becomes so marked that the largest objects can scarcely be discerned, and vision is reduced to little more than the mere perception of light. In such cases the most careful ophthalmoscopic examination fails to reveal any definite change in the optic disk, retina, or retinal vessels, and the proof that no serious organic alteration of structure has been produced is derived from the fact that by practice, when appropriate glasses are supplied, or the cataract removed, or when—as in cases of leucoma—an iridectomy has been performed, and clear images are once more thrown upon the retina, it resumes its former functions, and in course of time the vision may become perfect, the recovery being, in general, earlier and more complete the shorter the time that has elapsed since the eye has been disused. Hence, cases of strabismus should be placed under treatment as soon as the defect is observed, and the operation for congenital cataract should not be postponed, on this as well as on other accounts, providing there is no contraindication, for more than the second or third year, a time of life when it is generally successful.

Amblyopia seems to arise occasionally from masturbation in both sexes, and scattered notices of its occurrence may be met with in books and occur in practice. It is most common between the ages of fifteen and twenty-five, but may, of course, occur at a later period.

Amblyopia from Exposure to Bright Light.—Impairment of vision has been observed in those who have incautiously gazed at the sun, especially through a telescope, in those who have looked intently at the electric light, and in those who have been long exposed to the bright reflection of light from snow. Newton is well known to have suffered from scotomata through life, after a momentary glimpse of the sun through his telescope; and Deutschmann has shown that, when the rays of the sun are concentrated on the eye of a rabbit, serious and persistent lesions are produced, the retinal albumen becoming coagulated, and great vascular disturbance—indicated by congestion, diapedesis of blood-corpuscles, and dislocation of the pigment—being set up. A case of temporary amblyopia, after long inspection of the electric light, in a young telegraph engineer, was seen by the writer. There was some peripapillary œdema; rest effected a cure. In snow-blindness the impairment of vision usually soon disappears with removal of the cause.

Various cases of reflex amblyopia have been published, as after a vaginal injection which caused severe pain (Priestley Smith, *Ophth. Rev.*, Jan. 1884), apparently from thrombosis of the retinal artery.

Nyctalopia.—Amblyopia, in the form of night-blindness, is often associated with physical changes in the retina, and especially with pigmentary deposits in the form of patches, fine striæ, plexuses and stellæ, which in many cases run parallel to, or are in close contiguity with, the retinal vessels. This form of amblyopia has been frequently noticed as a result of scurvy, and several instances have been recorded by Dr. Alexander Bryson in the second volume of the Ophthalmic Hospital Reports. As a rule, the prognosis in nyctalopia, unless *retinitis pigmentosa* is present, is favourable, and recovery usually follows rest of the eyes, good food, and the administration of tonics.

1. Cerebral Amblyopia.—In a certain number of cases impairment of vision results from some lesion of the cerebral extremity of the nerves. In some instances the lesion is congenital, and consists in an imperfect development of the visual centres—whether optic thalami, corpora quadrigemina, or occipital lobes depends upon circumstances. It is then often associated with nystagmus. The same symptoms are observed in children who are suffering from hydrocephalus. It is sometimes seen as the result of uræmic poisoning, unattended with notable physical change in the retina or disk. It has been surmised that in these cases effusion into the corpora quadrigemina has taken place, and the blindness has, in some fortunate instances, proved transitory. It may result from simple anæmia of the centres, and the darkness that is felt just before swooning is of this nature. It may be a consequence of the growth of tumours or other coarse disease of the brain, as has been well shown by Hughlings Jackson, optic neuritis making its appearance at an early period, and white atrophy being the final result.

It must not be forgotten, however, that various cases have been recorded in which large tumours and extensive lesions of the brain have existed without any impairment of vision. According to Zehender, organic lesion of the cerebellum is insufficient to cause amaurosis.

A special form of amblyopia, passing sometimes into complete amaurosis, has been described recently by M. Dianoux under the title of anæsthesia of the optic nerves, characterised by more or less complete blindness without visible ophthalmoscopic lesion. It supervenes upon a central scotoma, first perceived after sleep, lasting for many months, and usually coexisting with cutaneous anæsthesia. Recovery may take place after appropriate treatment by potassium iodide, strychnia, and electricity, but it may also pass into white atrophy.

2. Crossed Amblyopia and Hemianopsia.—The phenomena of crossed amblyopia cannot be understood without a knowledge of the origin and course of the fibres entering into the composition of the optic nerves. On tracing the optic nerves backwards from the eye, they are seen to form a remarkable junction, named the chiasma, and to be continued beyond this, as the optic tracts, to the brain.

The course of the fibres of the optic tracts, on reaching the optic chiasma, has been the subject of much controversy, and is still open to further research. Some consider that there is here a complete decussation of the fibres of the optic tracts, others that there is mere juxtaposition without any decussation, whilst a third set of observers, who are constantly becoming more numerous, hold that there is a partial decussation. The chief arguments against this are, that occasionally the chiasma is absent and then complete decussation is observed, and, secondly, a median section of the chiasma has, in the hands both of Magendie and of Brown Séquard, been observed to produce total loss of vision. This result, however, does not appear to be constant. The evidence derived from the microscopic examination of the chiasma, from the effects of section in various parts of the optic nerve, chiasma, and tract, and lastly, from pathology, all point to the partial decussation, the non-decussating fibres chiefly supplying the outer side of the retina of the same side, and the decussating fibres, which are by far the most important, supplying the rest of the retina of the eye of the opposite side.

The view proposed by Charcot, and which has met with general acceptation, is that, admitting the fibres of the optic nerve to arise from one or more centres on each side of the cortex cerebri, some of these fibres course down through the optic tract of the same side, decussate in the chiasma, and are distributed to the inner, or nasal, side of the opposite eye. Other fibres arising from the same centre or centres, decussate in the corpora quadrigemina, and, descending in the opposite optic tract, pass to the outer or temporal side of the eye of the opposite side. Thus the whole of the fibres decussate, but some decussate in the chiasma and some in the corpora quadrigemina. Lesion of the cerebral centre of one side causes complete blindness of the opposite eye, because both sets of decussating fibres are destroyed. Lesion of the left optic tract would cause loss of the right half of each visual field, Lesion of the right optic tract would cause loss of the left half of each visual field. Lesion of the central portion of the chiasma causes temporal hemianopia; and lastly, lesion of the lateral portions of the chiasma would cause nasal hemiopia.

Neither the physiologist nor the pathologist can as yet localise an intracranial lesion occasioning blindness, and this is owing, not only to the wide connections of the optic nerves, but to the curious power of compensation that apparently exists between the opposite hemispheres; for it has been shown by Ferrier that sudden destruction of a very definite and limited portion of the brain, named the angular gyrus, on one side, causes complete blindness in the opposite eye; but if the opposite angular gyrus have remained intact, owing to this process or power of compensation, after a little while vision again returns in the previously blind eye, and, so far as can be ascertained, the animal sees as well with it as before. E. Munk, Crouineau, and others have found in their experiments that destruction of the angular gyrus is alone insufficient to cause blindness, though it may occasion amblyopia, but that destruction of the cortex of the whole occipital lobe invariably abolishes vision.

Amblyopia, proceeding to amaurosis, from cerebral disease, is usually accompanied with great dilatation of the pupil (mydriasis), but when resulting from spinal disease is associated with great contraction of the pupil (myosis).

In many of these cases other symptoms are present which point to the cerebrospinal origin of the disease. Amongst them are loss of tactile sensibility of one side of the body or of the face, hyperæsthesia, hemichorea, contraction of certain muscles, motor paralysis, and impairment of speech. The prominent eye-symptoms which have been fairly determined are, that there is amblyopia with contraction of the field of vision. Féré, who has put together the principal facts in regard to cerebral hemianopsia and amblyopia, distinguishes three groups: those which are post-apoplectic and transitory, those which are permanent, and those which are for the most part quite transient and accompany the affection known as 'la migraine ophthalmique.' The cases belonging to the first group result from the pressure produced by the effusion being propagated to, and acting upon, the optic tracts, which recover their function as soon as they have accommodated themselves to it, or as soon as absorption takes place. In the second group of cases the symptoms may be due to hæmorrhages or to the development of tumours, and the hemianopsia is most commonly associated with complete or incomplete motor hemiplegia; it is rare to meet with it in monoplegia; when, however, these are present, the face and upper limb are the parts chiefly affected. In cases of hemianopsia and motor hemiplegia aphasia may be present, and, in that case, the hemianopsia and hemiplegia are always on the right side. Hemichorea is occasionally present and is usually associated with hemianæsthesia. Hemianæsthesia not unfrequently occurs with hemianopsia, but the combination of hemianæsthesia, aphasia, and hemianopsia has only been observed in one case. The third group is characterised by various disturbances of vision, such as photopsia, often presenting the appearance of fortifications, and scotomata. There is also intense pain in the brow or temple, the attack culminating in nausea and vomiting. No very well-marked physical signs are present in this form, but the patients often suffer from dyspepsia, gout, rheumatism, or epilepsy. Between the attacks the vision may be normal.

Bellouard, who has closely studied the subject of hemianopsia, maintains that typical lateral hemianopsia is due to some lesion of the posterior extremity of the hemisphere near the posterior cornu of the third ventricle. Hemianopsia complicated with hemianæsthesia, with or without hemiplegia, is referable to participation of the direct sensory fibres of the pes pedunculi. Lastly, the co-existence of hemiplegia with hemianopsia renders it probable, he thinks, that the lesion is situated in the interior of the hemisphere, above and to the outer side of the optic radiation, that is to say, near the lenticular nucleus or external capsule. The lesion may, indeed, be in the paracentral lobe or centre for the movement of the limbs, but it is then distinct from that producing the hemianopsia.

3. Spinal Amblyopia. — (*a*) Tabetic Amblyopia—Amblyopia occurs as a symptom of progressive locomotor ataxy, and then constitutes the tabetic amblyopia of Charcot. The symptoms of this form of amblyopia, which is often syphilitic in its origin, are progressive deterioration of vision, the field of vision becoming gradually and concentrically limited. In some instances only one eye is affected, and complaint is made of a central scotoma, or dark spot, or several such spots, distributed over the field of vision. A greater or lesser degree of colour-blindness is usually present, red appearing of a very dark or almost black hue, and green appearing grey or dirty brown; whilst the secondary, or mixed, colours can no longer be distinguished. This defect of colour-vision does not necessarily proceed *pari passu* with the general failure of vision. Photopsiæ, or luminous phenomena of various kinds, are often observed. In the early stages of the disease, the fundus of the eye may appear almost natural. As the disease advances, however, the disk becomes gradually whiter, owing to atrophy of the capillaries. Microscopical examination shows that the axis-cylinders of the optic nerve fibres first undergo atrophy, and then the medullary substance, those nearest the arteria centralis retinæ, according to Leber, long retaining their normal characters. The connective tissue becomes greatly hypertrophied.

(*b*) Amblyopia is apt to occur in cases of grey degeneration of the posterior columns of the spinal cord; the disease in the nerves being of a similar nature, and affecting the whole, or a part only, of the optic nerves and tracts. It rarely occasions complete blindness.

The treatment to be recommended in this class of cases must vary, of course, with the special conditions of the case; but, speaking generally, it must be directed to the improvement of the general health. Fresh air, such exercise as can be taken, baths, friction of the skin, the administration of iron and strychnia; and silver nitrate, iodide of potassium, and perchloride of mercury may be prescribed, the effects of each being watched, and symptoms treated as they arise.

4. Toxic Amblyopia.—Amblyopia may be the effect of causes operating generally on the nervous system, the symptoms expressing themselves more strongly in the eyes, and these may now be briefly mentioned.

(*a*) *Amblyopia from Tobacco.*—This form of amblyopia has been made a subject of special study by Mr. Jonathan Hutchinson, who points out that since many men smoke, and, indeed, smoke inordinately, whilst few are affected in their powers of vision, it is probable that when tobacco produces amaurosis or amblyopia it does so in virtue of an idiosyncrasy, whilst the effects of the poison are undoubtedly augmented by the abuse of alcohol and other excesses. It occurs, as might be expected, almost exclusively in men, in some cases the actual quantity consumed not being large, though the effects are well-marked. In the great majority of instances both eyes are affected, and to nearly an equal degree, the vision becoming lowered to one-half of its normal sharpness. The progress of the disease is slow but continuous, though rarely proceeding to total blindness. It is usually accompanied by a state of general debility and defective tone of the nervous system. The patient complains of seeing everything as if in a fog, and the sight is impaired both for form and colour. The impairment affects chiefly the central part of the field, the defect being most perceived in bright lights.

The ophthalmoscopic symptoms in well-marked cases are that the disks are paler than natural, especially on the outer part, the surface swollen, and the margins blurred and indistinct, though without presenting the aspect characteristic of optic neuritis, peripapillary œdema being absent. The retinal vessels are smaller and less numerous than in the healthy eye.

In young persons, and in those in whom the attack has been induced by recent and excessive addiction to smoking, perfect recovery may, in general, be obtained by giving up the habit entirely; but in old smokers, in whom the progress of the affection has been steady and prolonged, and in whom, also, the atrophy of the disk is clearly perceptible, smaller improvement, or the arrest of the disease, is all that can be expected. Tonics, such as strychnia, iron, quinine, and sulphate of zinc, have appeared to be of service in aiding the nervous system to regain its tone.

(*b*) *Amblyopia from Alcohol.*—The symptoms here are similar to those observed in tobacco amblyopia. The patient complains of more or less sudden failure of vision, and this may be so great as to incapacitate him from all close work. The central part of the field is most affected. There is great loss of vision for colours, especially for green and red, which are described as appearing of a muddy tint. In the early stages there is probably some congestion of the optic disk, but it subsequently becomes pale, with woolly aspect, and finally white. In some cases of alcoholic amblyopia changes, perceptible under the microscope, have been observed. Thus, Uhthoff has given the results of section of the optic nerves in two alcoholists, who during life presented pallor of the temporal half of the optic papillæ. In one of these there was a central scotoma, or defect of vision, whilst the other presented at one time typical alcoholic amblyopia, which, however, had in great measure passed off before death. In both cases the anatomical lesions were nearly identical, differing only in their intensity. In both there was hypertrophy of the interstitial connective tissue, with considerable proliferation of nuclei, new formation of vessels, and atrophy of nerve-fibres. The degenerated nerve-fibres occupied the region between the central retinal vessels and the periphery of the optic nerve. In one case the chiasma and optic tracts were examined, and it was found that the degenerated fasciculi gradually left the peripheric region, and, in the optic foramen, formed a cylindrical mass near the centre of the optic nerves. In the chiasma itself a group of degenerated fibres could be distinguished in each half, which extended along the upper and inner part of the tractus. The treatment must consist in the absolute interdiction of alcohol in every form, the administration of tonics, change of air and scene, and general restorative measures. Remarkable cases of recovery may, under the altered conditions of life, be sometimes observed.

(*c*) *Saturnine Amblyopia.*—Amblyopia from the toxic influence of lead, or saturnine amblyopia, has been noticed by many writers. The symptoms are those of acute, subacute, or chronic lead-poisoning generally: headache, local paralysis, and blue line on the gums, with gradual deterioration of vision.

The ophthalmoscopic signs are not strongly marked, but there is probably a stage of hyperæmia of the disk, if not of actual neuritis, and this is succeeded by a period during which the disk becomes pale, ill-defined at the margin, and ultimately white.

(*d*) *Quinine Amblyopia.*—Besides alcohol, tobacco, and lead, some other drugs have been known to cause amblyopia; thus cases are reported where it has resulted from excessive doses of quinine, the amblyopia amounting, in some instances, to almost complete amaurosis. It usually passes off as soon as the use of the remedy is discontinued, though it may, in some instances, leave persistent dulness of vision and contraction of the field behind it. The ophthalmoscopic symptoms are few and slight, consisting chiefly of pallor of the disk, with some diminution in the size and number of the retinal vessels. Belladonna again, with several other solanaceous plants, has been known to produce, when taken in poisonous doses, temporary amblyopia.

(*e*) *Amblyopia from Malarial Poisoning.*—Occasional or exceptional conditions of amblyopia have been noticed in intermittent fever. Peounow, for example, reports four cases of slight diminution of the sharpness of vision during the attack, together with impairment in the perception of colours, or even a chromatic scotoma in the centre of the field of vision, which disappeared quickly under the influence of quinine.

In consequence of the general failure of power in the constitution and bodily powers in diabetes, it is not surprising that failure of accommodation should occur; and Trousseau has drawn attention to this as one of the most common as well as one of the most remarkable of the symptoms of saccharine diabetes. But, apart from this, there is probably a form of amblyopia in diabetes which owes its origin to changes in the optic nerve, and there is still another in which the amblyopia is essentially due to retinal hæmorrhages.

5. Diabetic Amblyopia.—In diabetic as in tobacco amblyopia, there is sometimes an area of red blindness near the centre of the field of vision.

But few observations have been made upon the microscopical aspect of the optic nerve in cases of diabetic amblyopia. Drs. Edmunds and Lawford, however, had the opportunity of making sections of the optic nerve in a case of diabetic amblyopia, in which during life the appearances presented by the fundus of both eyes were normal. It should be stated that the patient had at one time indulged immoderately in the use of tobacco. No macroscopic changes were perceptible in the nerve, but, under the microscope, marked changes were found in a group of the nerve-bundles throughout the whole length of the orbital part of the nerve, the trabeculæ, and the walls of the nutrient vessels were found to be greatly thickened, the fasciculi of nerve-fibres seemed to have the fibres in them destroyed, their place being taken by an irregularly granular structure, containing a large number of nuclei which stained with colouring agents.

6. Renal Disease.—Impairment of vision is sometimes the first symptom that leads to the discovery of albuminuria, and it is a very common concomitant of the later stages of that affection. *See* Optic Nerve; Retina, Affections of the.

7. Amblyopia in Pregnancy.—Amblyopia not unfrequently occurs in the course of pregnancy, and it may range through all degrees, from slight impairment to almost complete loss of vision. In the slighter cases the defective vision is probably due to loss of accommodation from mere weakness and exhaustion of the nervous system in general, and of the ciliary muscle in particular, and is consequently most marked in those who are the subjects of hypermetropia, though this may previously have passed unnoticed. In the more severe forms, well-marked ophthalmoscopic symptoms may exist, which bear a close resemblance to those of albuminuric retinitis, the optic disk presenting the aspect of optic neuritis, its margins being ill-defined, its surface swollen and woolly, the veins full and dark, tortuous and varicose, the arteries small, and seen with difficulty. Here and there large areas of effusion of whitish colour are to be seen on the surface of the retina, with irregular patches of hæmorrhage. These conditions are commonly associated with the presence of albumen in the urine, and it is highly probable that they proceed from pressure exerted by the uterus on the renal vessels, and especially on the renal veins, since the affection usually commences about the seventh month of pregnancy, and the symptoms continue to increase in intensity to the full term. After delivery is effected, they gradually decline, and in some instances perfect recovery may take place, though in others the vision of one or both eyes may be permanently impaired, and, under the ophthalmoscope, more or less advanced white atrophy, with discoloured areas, indicating the former presence of retino-choroiditis, may readily be seen.

The treatment of this form of amblyopia should, unquestionably, be the induction of premature labour, which probably acts by relieving the renal vessels from the pressure to which they have been subjected, and by effecting a restoration of the normal conditions of circulation in the capillaries of the kidney. The writer has seen several cases where the adoption of this plan of treatment has lead to immediate, great, and persistent improvement in the vision of eyes which appeared to be almost hopelessly blind, in which, indeed, there was little more than quantitative perception of light. On the other hand, he has known cases in which, when pregnancy was allowed to progress to its natural termination, the visual troubles were only premonitory of death by convulsions, or to blindness of an incurable nature.

8. Amblyopia from Cardiac Disease.—An intermittent form has been described by Nettleship, associated with valvular disease of the heart, the characteristic symptoms of which are, that the impairment of vision supervenes suddenly, lasts for a short time only, varying from a minute or two to an hour or more, and quickly disappears. The attack is not limited to one eye, but most frequently affects only one, and not always the same. It is probably connected with vascular constriction of an irregularly periodic character, and primarily dependent on some lesion or disturbance of the nervous system. The treatment should be directed to the heart, and to improvement in the general health of the patient.

9. Hysterical Amblyopia. — Impairment of vision not unfrequently occurs in hysteria. In hemianæsthetic hysteria, amblyopia, with concentric contraction of the field of vision, is apt to occur on the same side as that on which the anæsthesia exists. In the cases of hysterical amblyopia, examined by Landolt at the Salpêtrière, it was found that there was concentric contraction of the visual field for white light and for colours. The cause of this condition is not known, but it may, with much probability, be referred to alterations in the calibre of the blood-vessels leading to irregular, imperfect, or perverted nutrition of particular regions. Ophthalmoscopic examination, in some instances, demonstrates the presence of optic neuritis.

Diagnosis.—To determine the nature and degree of amblyopia, where no reason for suspecting simulation exists (*see* Vision, Feigned Disorders of), a methodical examination of the eyes should be undertaken, and special attention should be paid to the sharpness of vision for form and colour, the field of vision, the physical condition of the eye, including the appearances seen with the naked eye and with the aid of lenses, by direct and oblique illumination, the refraction of the eye, and, lastly, the appearances presented on examination with the ophthalmoscope. *See* also Visual Acuity; Ophthalmoscopy; Perimetry.

Henry Power.

AMBULANCE.—The term ambulance is so elastic in its acceptation, that it is difficult to know how to limit its scope. In the widest sense it signifies a movable, in contradistinction to a fixed or stationary, means of affording relief. The patients are sought for by the doctor and his assistants, instead of the patient coming to the doctor. First aid to the injured cannot be dealt with in this short article, but only the means of carrying or transporting the sick or injured.

In all times such means have been used, but the modern stretcher has supplanted the historic buckler, the waggon the war chariot, the litter and cacolet the haphazard throwing across a horse or camel's back.

To follow the different plans now in use in peace and war, it will be profitable to divide the means employed into carriage by hand, by stretcher, by waggon, by cacolet, by litter, and by railway carriage.

I. Carriage by Hand.— 1. *When only one bearer is available.*—*a.* If the patient can stand, the bearer places himself at the uninjured side, say the right. The bearer then places the patient's right arm around his (the bearer's) neck and grasps the wrist with his right hand. The bearer's left hand now grasps the patient's left hip. By this manœuvre the patient's weight is thrown on to the bearer, who can thus help him along or even carry him.

b. By the fireman's lift. Standing in front, the bearer seizes the patient's right wrist in his left hand, then bending down until his right shoulder is below the patient's right hip-joint, he throws the patient across his shoulders and back, and grasps the legs with his right arm.

2. *When two bearers are available.*—*a.* Two-handed seat. The bearers face each other, the right-hand bearer presents his right hand for the left bearer to grasp with his left hand, or *vice versâ*; the free hand of either bearer then grasps the clothing over the hip, loin, or shoulder of the other, to form a back or support for the patient. The clasped hands are brought firmly together, and on these the patient sits; the patient's arms should encircle the bearers' necks.

b. Three-handed seat with support for the back. The bearers face each other; the right-hand bearer grasps his own left forearm; the left-hand bearer with his left hand grasps the right bearer's right forearm, who with his free hand grasps the left bearer's right forearm. A triangular seat is thus formed. The left bearer's free arm is placed on the right bearer's shoulder, to form a support for the back.

c. Four-handed seat. The bearers face each other; each grasps his own left forearm, and approaching hands, each man seizes the right forearm of the other with the disengaged hand, a sedan-chair being thus formed. By any one of these methods patients may be carried some distance, or placed on the tail seat of a waggon or on a cacolet. If the patient cannot stand, others might lift him on to the seats thus formed.

II. Carriage by Stretcher.—Stretchers consist essentially of a couple of poles with canvas or other material stretched between them, and must be long enough and broad enough to carry a patient.

a. Stretchers for use in hospitals. The best form is a piece of canvas 6 feet 6 inches long, 1 foot 10 inches wide, with a couple of pole-sheaths at the sides. This piece of canvas can be passed below a patient as is an undersheet, and the poles, 8 feet long, slipped into the sheaths when it is wanted to move the patient, say from the bed to the operating table, or *vice versâ.* A couple of iron traverses to keep the poles apart can be adjusted after the poles are in place.

b. Stretchers used in the field or in the streets must have supports in the form of legs or wheels. The army pattern stretcher has wooden wheels, whereby it can be rolled into an ambulance waggon. The canvas is 6 feet long, 1 foot 11 inches wide, the poles are 7 feet 9½ inches long, and the traverses made to bend in the centre with an easily opened and easily closed joint.

Methods of placing a patient on a stretcher:—

1. Four bearers are assigned to each stretcher according to the army regulations. The stretcher is placed parallel with the patient, close to, say, his right side. Three bearers take post on the left side of the patient, one opposite the shoulder, a second opposite the hip, and a third opposite the knee. The fourth bearer places himself on the opposite side of the stretcher to the patient. The three first-named now raise the patient by placing their hands below the patient, whilst the fourth bearer pushes the stretcher beneath the patient when he is raised, and then helps to gently lower him on the canvas.

2. Another method, that practised by the St. John's Ambulance Association, requires three bearers only. The stretcher is placed in line with the patient, either at his head or feet; one bearer takes stand on either side of the patient opposite the middle of his body, and each passes his hands beneath the patient's shoulders and hips until the fingers of the bearers meet, when they grasp each other's hands; the third bearer passes his hands beneath the legs, and all rising together advance by a side step over the stretcher.

3. A still better method is as follows. Place the stretcher in a line with the patient's body at the head or feet. Two bearers now stride across the patient, one opposite the body, the other opposite the knees. Both, bending down and seizing the patient, raise him a sufficient height from the ground to allow the third bearer to push the stretcher between their legs, i.e. beneath the patient.

4. When two bearers only are available, the stretcher is laid in a line with the patient's body at the head or feet. The two bearers then stride across the patient, and raising him a sufficient distance, straddle forwards with their burden until over the stretcher.

To *carry* a stretcher two bearers are sufficient, but a third or fourth are useful to look after the patient and to relieve the others in carrying. A patient should always be carried feet first, except when going up a steep hill. If the patient is suffering from a broken thigh, he ought to be carried head first even coming down hill, and feet first going up, to prevent jostling of the fragments one on another. The bearers walk in broken step to prevent the stretcher swinging. The steps taken must be short—twenty inches; the knees are to be kept bent, and the feet lifted high off the ground. Leather or canvas belts over the bearers' shoulders and around the handles of the poles, are efficient aids in carrying. In going up a hill the shorter bearer, if there is a difference in height, should go in front, and *vice versâ* coming down. On going up or down a slope, the aim is to keep the patient as nearly as possible on a level, and this may be done to some extent by either bearer raising or lowering his end of the stretcher as occasion arises.

Improvised Stretchers.—1. A blanket and broom-handles.—The blanket, rug, horse-cloth, plaid, &c., is laid flat on the floor or ground, and a couple of broom-handles, pitch-forks, goal poles, rifles, &c., wrapped up in it one from either side until within a foot of the centre of the blanket; the patient is then laid thereon, and four bearers are at each corner to grasp the poles where they are wrapped in the blanket with one or both hands. This will do for short distance carriage, but for longer distances, say half a mile, use the following.

2. Secure a stout loop at the four corners of a blanket, then double it over so that the two loops at either end are brought together, then slip one pole through the loops on one side, and another within the doubling of the blanket on the other side.

3. A ship's hammock may be arranged to be carried on a single pole, and borne on the shoulders, or two poles may be utilised by a little management.

4. A couple of poles may be kept apart by cross poles tied or nailed at either end, and then the bottom can be made up of straw, ropes, belts, knapsacks, &c.

5. Coats are utilised thus:—Two long poles or four rifles are required, the pairs of rifles being lashed together at the muzzle-ends; the sleeves of the coat or coats are then turned outside-in. The coat is laid on the ground, the back of the coat next the ground; the two coats being in line, the rifles or poles are pushed through the sleeves, and the coats buttoned down the front in the usual way.

III. CARRIAGE BY WAGGON.—An ambulance waggon is a four-wheeled vehicle, set on easy springs and drawn by two horses. It is capable of accommodating two patients lying on stretchers in the body of the vehicle, three more sitting on the front seat, and three, two patients and an attendant on the hind seat—eight in all. Over all is a canvas covering, and on the waggon are fitted a small water-tank and various boxes, ready to convey stores on an emergency. The rifles of the men lying down are placed beneath their stretchers, and their kits in the box beneath the drivers' seat. Waggon-stretchers are now essentially the same as the field stretchers, both being provided with wheels. To place the stretchers in the waggon the bearers halt a few paces off the tail of the waggon. The four bearers then seize the poles at the sides, as with the blanket-stretcher, and advance with a side step until the front wheels rest on the floor of the waggon. Then the stretcher is gently rolled onwards along the waggon floor.

On the hind seat are placed those patients who are unable to walk; on the front seat only such patients as are able to walk, since it is necessary to go up a ladder to reach it.

IV. CACOLETS are folding chairs, hooked one on each side of a pack saddle, carried by a mule or pony. The patients are necessarily in the sitting posture, their faces towards the animal's head. Patients suffering from fractures or severe injuries to the lower extremities, or who are very weak, must not be put on a cacolet. The cacolet is loaded by two bearers carrying the patient by a hand-seat, back first, towards the chair, on to which he is raised. The feet are placed on the foot-board and the waist-straps buckled to keep the patient on.

V. A LITTER is a light iron framework couch, capable of being placed on the side of a mule or pony for the purpose of transporting sick or wounded. A mule can carry two litters. As the mule stands higher in front than behind, the patient lies with his head towards the animal's head. Foot-rails and side-rails are placed to prevent the patient slipping backwards, or rolling over the edge. To load a litter it is laid on the ground, the patient laid thereon by one or other of the methods of placing a patient on a stretcher. The litter is then raised to the animal's sides, and the apparatus hooked, buckled, and belted thereon. Litters and cacolets can be folded into very small bulk when not in use.

VI. CARRIAGE BY RAILWAY is effected in:—

1. Invalid carriages. These are simply travelling hospitals, in which the patients are placed on stretchers in bunks instead of on beds. They have all lavatory conveniences and medical and surgical necessaries. Each carriage can accommodate eight patients in two tiers on either side.

2. Second-class carriage seats, being cushioned but not partitioned, are available for a couple of stretchers. Two cross-pieces of wood are laid from seat to seat, each about a foot from the door. The stretcher has to be slightly tilted to get it through the door (1 foot 10 inches wide). A couple of stretchers can be laid along the seats, one on either side, and space left between for the attendant.

3. Goods-waggons and cattle-trucks can be utilised, but each stretcher requires four steel springs on which the handles of the stretcher can be placed. Three stretchers only can be placed on each waggon. The stretchers should not touch the sides of the waggon.

Surgical assistance in the field is regulated thus:—

I. Position of the 'first help station.'—This is immediately in rear of the fighting line, and moves with the combatants. Here only first dressings are applied, when the patient is carried on a stretcher to—

II. The second help or 'collecting station,' 1,000 yards in rear, or just out of rifle range. Here the wounded are placed in waggons, and the bearers are left free to return. Only first aid or hasty re-adjustment is to be here applied, as the patient is hurried off to—

III. The third help, or 'dressing station.' This is again 1,000 yards behind the collecting station, or out of the range of artillery fire. Here the wounded are sorted, ticketed, examined as regards the nature of their injuries, and such operations as are evidently imperative are to be done, but this is not the operating station. From hence the wounded are sent to—

IV. The fourth help, or 'field hospital station.' This should be about four miles to the rear of the combatants, and here the wounded are treated, amputations performed, &c. as is usual in an ordinary civil hospital. Those who can be are sent as soon as possible to—

V. The 'base hospital,' at the seaside, it may be, or in some town the base of the military operations. JAMES CANTLIE.

AMETROPIA.—Any optical condition of the eye, in which, accommodation being suspended, entering parallel rays are not accurately focussed on the retina. The term includes MYOPIA, HYPERMETROPIA, and ASTIGMATISM. *See* REFRACTION, Errors of.

AMPUTATIONS. — GENERAL CONSIDERATIONS. — Amputations, having for their object the removal of a limb or portion of it, are performed, as a rule, in cases of severe external injury, gangrene, morbid growths, many forms of bone and joint disease, intractable ulcers, malformation, aneurism, &c. Re-amputations are recognised and performed on account of certain affections of the stump, such as the conical or 'sugar loaf' stump; necrosis, neuromata, persistent pain, large adventitious bursæ, aneurismal dilatation of vessels, &c. *See* STUMPS, Affections of.

Amputations have been classified with special reference—(1) to the form of flap; (2) the situation where the bone is divided; (3) in traumatic cases, the time after the receipt of the injury that the operation is undertaken; and (4) there are *partial* and *complete* amputations, as of the foot. Then we speak of amputations by *circular* or *flap* methods, and of amputations in the *continuity* or *contiguity*, i.e. where the division of the tissues includes that of the bone at a point more or less removed from its extremity, or passes through an articulation. Another classification (Alcock's) is into *primary*, *intermediary*, and *secondary*. In the primary, the operation is performed immediately after the receipt of the injury and before there is evidence of any febrile disturbance. Secondary amputations are those undertaken at a time more or less remote from the date of the injury, and when suppuration as well as other unfavourable sequelæ, such as bone or joint disease, have supervened. Intermediary amputations are those undertaken subsequent to febrile excitement, but before the occurrence of the other results just mentioned.

In the history of amputation three distinct eras are recognised. In the first of these, operating surgeons made no attempt to form any kind of flaps, the limbs being removed at times by the knife; the 'Cauterium cultellare' (Hildanus); the chisel and mallet (Scultetus, Heister); the pincers (Guillemeau); and the guillotine (Père Botallus). The main object surgeons had in view was, apparently, not so much to obtain a shapely and useful stump as to take precautions that the patient did not succumb to hæmorrhage during the operation. To prevent death from this cause many and various were the devices had recourse to; such as division of the tissues with red-hot irons, plunging the stump into boiling pitch or oil, and the application of variously shaped cautery-irons to the bleeding vessels. It is not surprising, therefore, to learn, as we do, from the writings of Thomas Gale (1563), of the dread people had of this method of checking hæmorrhage by the 'terrible fire, by means whereof many people perished,' and these operations were not unnaturally stigmatised as the 'opprobria of surgery.'

In the second era, commencing towards the end of the sixteenth century, the circular method was advocated and practised. There is evidence that the merits of it were appreciated in 1560 by Ambrose Paré, to whom we are indebted for the introduction of the ligature as a means of arresting hæmorrhage. Although the circular method is mentioned in the writings of Celsus, as is also the ligature, it was not until 1560 that the ligature obtained recognition. The introduction of the ligature, and the invention, a century later, of the tourniquet by Morel (1674), which instrument was advocated by Petit (1708), were doubtless main factors in enabling surgeons to devise better methods of amputating than those previously adopted.

Several modes of performing a 'circular' amputation are recognised—for example, those of Louis, Petit, Mynors, Alanson, O'Halloran, Bell, and others. In the first of these the skin was retracted and two bandages were applied—one above and the other below the line of incision, in order to steady the soft parts, which were divided by a circular incision down to the bone. Then, in order to allow the superficial muscles to retract, the operator removed the upper bandage, and the deeper muscles were divided by a second incision, and the bone was divided on a line with the retracted superficial layer at that point. This Malgaigne states is 'very nearly the method described by Celsus, as Louis himself allows.' The practice of dividing the skin down to the fascia in the first instance, at a point below where the bone is to be divided, retracting the skin and subsequently dividing the muscular tissues down to the bone on a level with the retracted skin, was introduced by J. L. Petit (1708). Mynors, of Birmingham, went a step farther, and dissected back and reflected the skin to a point on a level with the bone-section. These methods were improved on by Alanson (1782), who introduced oblique division of the muscles, the wound eventually resembling 'a conical cavity, the apex of which is the extremity of the bone.' The parts thus divided he states are 'obviously the best calculated to prevent a sugar-loaf stump.'

The 'triple incision' of B. Bell, of Edinburgh, consisted in the primary division of skin and fascia; secondly, the muscles; and finally, the bone. Mr. Hey, of Leeds, and Desault, have also advocated amputations by 'triple' incision. Mr. Hey advised division of the posterior muscles at a somewhat lower level than the anterior, having regard to the greater tendency of the former to retract and contract.

Other modifications of the 'circular' method have also been proposed, such as that in which two semilunar incisions (Syme and Liston) are made, one on the anterior and the other on the posterior aspect of the limb, the alleged advantages of which are the greater facility afforded for the reflection backwards of the flaps. Another modification is that of Lenoir, having also for its object the facilitating a dissection backwards of the integumental flaps. Having made a circular incision, not passing deeper than the fascia, an inch and a half below where the bone is to be divided, a vertical incision from this point is made, and the two angular flaps can then be easily dissected back, the incision assuming a somewhat oval form. The method appears mainly applicable to amputations of the leg below the place of election, and to the lower third of the forearm.

The credit of priority in the introduction of flap amputations is due to Mr. James Young of Plymouth (1678), who, in amputations of the leg, recommended 'a flap of the membranous flesh covering the muscles of the calf.' Subsequently Verduin recommended a similar flap, but, instead of cutting it from below upwards, he made it by transfixion. Many have been the forms, varieties, and modifications of the amputation originally suggested by Mr. Young: single and double flaps, unilateral, bilateral, antero-posterior, oval, and rectangular. In thigh amputations, O'Halloran first recommended the long anterior and short posterior flap. This method, with slight modifications, has been practised and advocated by B. Bell, Liston, Sédillot, Fergusson, and Spence.

Among the more recent developments of flap amputation are those of Carden and Teale, together with the operation at the knee of Gritti, and the modification of it to which the writer has given the name of supra-condyloid. The advantages of the single flap method are thus epitomised by Carden:—'The facility afforded for amputating either through the knee or through any part of the lower end of the femur, thus proportionately avoiding the shock of higher amputation, and the risks of exfoliation, pyæmia, &c., attendant on sawing through the cylinder of the bone; the simplicity of the whole proceeding, and small extent of the wound; the favourable position of the flap for dressing, and for the escape of discharge; painlessness and quietude of the stump, the principal nerves being divided high up and drawn out of reach of pressure or exposure; the fitness of the stump to stand and walk upon, the bearing being broad, and the skin employed being accustomed to bear the weight of the body in kneeling; the cicatrix being drawn clear of the point of the bone, out of the reach of pressure.'

Notwithstanding these alleged advantages, and the fact that the operation was approved of by Professor Syme, the writer has known the 'surgical calamity' of sloughing of the flap to occur after this operation, and that in more than one case. This is most likely to happen in weakly, delicate, anæmic subjects, and the operation therefore, in such cases, should not be lightly undertaken. When there is reason to apprehend this accident supervening, the flap should be made wider than is recommended by Carden. Thus the risk of sloughing is diminished. It is also to a great extent obviated by the modifications of Sir J. Lister and Professor Spence, in which procedures the anterior flap consists, not merely of integument, but also of muscular tissue. The chances of the accident occurring are, however, more effectually avoided in the percondyloid amputation of Gritti, or in the supra-condyloid modification of it, in both of which operations the patella is included in the anterior flap.

The flap amputation which best fulfils all the requirements needed is the rectangular method of the late Mr. Teale, the special advantages of which are apparent not merely in thigh amputations, but also in those of the leg, fingers, arm, and forearm. These advantages are: the remote danger of sloughing of the flaps, the abundant covering for the bone and consequent diminished risk of the formation of a conical stump; the cicatrix not being on the face of the stump, but placed posteriorly and above it; the facilities for the escape of fluids from the wound, rendering drainage almost unnecessary; the principal nerves and vessels, being in the posterior flap, are not liable to the injurious effects of pressure; and the main vessels being in the posterior flap, the operator can find and secure them with the minimum amount of disturbance to the wound. It has also been claimed for this operation that the stumps can bear the weight of the body better than after the ordinary circular or flap operations. This opinion, however, though the probabilities of its accuracy are great, is one which the writer is not disposed to endorse.

Two main objections have been made to Teale's operation: one is the length of time that its performance occupies, and the other that the great length of the anterior flap requires a high division of the bone. Although previously to the discovery of anæsthetics (1846), the objection to a surgical operation because of the length of time it occupied would not have been groundless, that objection cannot now be urged. Besides the advantages to the patient obtained by anæsthetics, viz. the prevention of suffering, diminution of shock, and subsequent oblivion of the details of the operation, must be added those enjoyed by the operator—namely, power to act with deliberation, calmness, and freedom from anxiety, care, and hurry; and these advantages are as great to the operator as those already mentioned are to the patient.

The second objection to Teale's amputation is based on the alleged necessity for a higher bone division than in other amputations. There can be little doubt that by following accurately Mr. Teale's directions, in very many instances, both of leg and thigh amputations, a low division of the osseous structures would be impracticable. This is not of so much consequence in amputations of the leg, since the lower third of that limb is not, as a rule, a situation selected by surgeons for the performance of amputation; but in the thigh, the case is different. Here it is all-important to save as much as possible of the bone, not only with the view of subsequent adaptation of mechanical appliances, but also because in thigh amputations, as Dieffenbach has expressed it, 'the danger increases inch by inch.' To avoid a high section of bone, two modifications of Teale's amputation have been proposed by Sir J. Lister and Mr. Wharton. Having regard to the forward position of the bone among the muscles, the posterior surface of it being anterior to the longitudinal axis of the limb, Sir J. Lister makes the following proposal:—An anterior flap, two-thirds of the diameter of the limb, 'after being marked out by carrying the knife through the skin and fat, should be raised so as to contain a good deal of muscle,' and a posterior one, rather more than half its length, of rounded shape, is then made, the integuments of which should be dissected up before the posterior muscles are divided, 'in this way preventing the effects of undue contraction.'

The high division of bone, and extensive division of muscular tissue—the two alleged defects in the rectangular method—are also got rid of by the modification proposed by Mr. Wharton:—'Let the measurements for Teale's amputation be accurately taken and mapped out; but, instead of dividing the bone at the site directed by him, let it be sawn at the situation corresponding to the inferior termination of his posterior flap, and let the superior boundary of his anterior flap be limited by the same plane. The saving of bone thus effected will be considerable, and therefore tend directly to diminish the mortality of thigh amputations. According to this method the anterior flap will be shorter by a fourth than Teale's, and there will be no posterior flap.'

But against this modification it is objected that the cicatrix is too near the surface of the stump; that there is tension of the soft parts on the face of the stump; that the covering is insufficient; that, owing to retraction of the tissues, the posterior surface of the bone projects, and is denuded of soft tissues; that there is a liability of the cicatrix becoming adherent to the immediately subjacent bone; and that the risk of pyæmia is increased. The writer's experience would, however, undoubtedly tend to establish the groundlessness of most of these objections; but, though willing to acknowledge and bear testimony to the excellence of the results obtained by Wharton's modification, he fails to recognise the alleged defects of the rectangular method as originally recommended by Mr. Teale.

For the circular and flap methods, special advantages are claimed. Among those said to belong to the circular method is diminution of shock, the area of the wound being less in extent than in 'flap' operations. It has also been claimed for circular amputations that, owing to the vessels being divided at right angles to their continuity, the risk of secondary hæmorrhage is diminished, no fenestrated openings in them being possible, a result which may occur in flap amputations, especially when done by transfixion. Again, it is claimed that the risks of phlebitic inflammation are diminished, the wounds in them being less in extent than when divided obliquely, as in flap amputations. And lastly, it is alleged that the mortality is less; but the foregoing advantages appear to be highly problematical. On the other hand the advocates for flap amputations claim greater shapeliness of stump, possibility of operating with greater speed, diminished risk of conical stumps resulting, better covering for the bone, and the stumps being better adapted for the subsequent adjustment of prothetic mechanical appliances.

Previously to the introduction of anæsthetics and Listerian antiseptic practice, the main objections urged against flap amputations may not have been altogether groundless, but that they are so now appears to be beyond question, and there is moreover a general consensus of opinion among operating surgeons that, in the majority of cases, 'flap' amputations are to be preferred, as giving the most satisfactory results.

The Performance of an Amputation.—Before performing an amputation the precautionary measures to be adopted may be considered. The day previous to the operation the patient's bowels should, if confined, be acted on either by an enema or by some mild but efficient aperient. On the morning of the operation the food given should be small in quantity, and of the lightest and most easily digested quality. In some of the more important amputations, such as those of the thigh, at the hip, knee, or shoulder joints, the writer is in the habit of giving the patient an antiseptic (eucalyptol) bath, it being desirable to render the part to be operated on as completely aseptic as possible by diligent washing, and getting rid of all superfluous epidermic accretions by rubbing with soap and pumice. The application of turpentine or ether to the part, to get rid of greasy matters on the skin, is strongly to be commended, and then swathing the limb in moistened carbolised or eucalyptol gauze. The next point is the prevention of hæmorrhage. The tourniquet of Petit and the various modifications of that instrument have been so entirely superseded by the introduction and employment of the so-called Bloodless Method of Esmarch, that any detailed description of the former instruments and their mode of application is unnecessary. But Esmarch's method is not applicable in all cases—for example, in cases of gangrene, or when there is any purulent deposit or infiltration. In such cases it would be preferable to adopt the plan of elevation of the limb for some time previous to the amputation. There are, it has been stated, certain alleged defects connected with Esmarch's method. These are the pain it causes and the liability to produce sloughing and paralysis, especially the latter, when applied to the arm. The writer, after an experience of ten years' constant use of this 'bloodless' method, can bear testimony to having never on any occasion seen those accidents which, in the practice of others, are said to have occurred. On the other hand, he is not prepared to endorse the views of M. Marduel, who in his exhaustive paper, states that the artificial production of a local anæmia not only is unattended with the risks already alluded to, but promotes rapidity of union and diminishes the risk of traumatic fever.

As regards paralysis of the arm following the application of the elastic tubing or tourniquet, Von Langenbeck suggests that for the tubing a flat elastic bandage be substituted. The effect of this would be to diffuse the pressure, and in that way diminish the chances of any mishap occurring from an undue amount of pressure at one point where there was the minimum amount of covering and protection to the nerves. With the same object Sir J. Lister advocates preliminary elevation of the limb, or the 'method of position,' as being one in which an equal amount of local anæmia is produced, with, at the same time, an immunity from the danger of other accidents.

In certain amputations, such as those at the hip and shoulder-joints, other means for the prevention of hæmorrhage than these are employed: in hip amputations, the abdominal clamp of Sir J. Lister and Mr. Davy's rectal lever; and in disarticulations at the shoulder, the method of compression of the subclavian artery on the first rib. These, however, will be better discussed in connection with a detailed description of those procedures. The various forms of forceps for seizing the vessels for the purpose of applying a ligature are the so-called 'bull-dog,' Nunneley's, Liston's, and Von Langenbeck's catch-forceps, and, lastly, Kœberle's, which is, in the writer's opinion, superior to all others hitherto devised. In cases where the vessel to be secured retracts greatly, it often happens that the tenaculum will succeed when the above-mentioned instruments fail. For example, in amputations of the leg, the inter-osseous vessels are especially likely to give trouble from this cause. In such a case the tenaculum will be found most useful. With the object of preventing this difficulty arising Sir G. Porter makes a practical suggestion —namely, that the inter-osseous structures should be divided with the catlin at a situation a little below the point where the bones are divided.

In what may be termed the pre-antiseptic era surgeons had, and with reason, a great dread of phlebitis being induced by the ligature of veins, and the practice, consequently, was universally condemned. The introduction, however, of Listerian antiseptic practice has effected a complete and signal revolution. The writer is unable to recall a single instance in which the ligature of a large or small vein—efficient antiseptic precautions being taken—was attended with any secondary trouble whatever. The sailor's 'reef-knot' is the best to employ, and both ends should then be cut short. For the larger vessels chromicised catgut of medium thickness is to be preferred, as its absorption takes a longer time, but in vessels of smaller calibre ordinary carbolised catgut may be used.

The instruments—amputation knives and scalpels—for the division of the soft structures may here be alluded to. The first-named instruments may be divided into two classes—those rounded at the ends and with strong thick straight backs. These are, as a rule, used in 'circular' amputations. The other class consists of long comparatively slender blades, and pointed at the extremity. These 'catlin' knives, as they are usually called, are employed generally in transfixion flap methods. In certain amputations, such as Carden's, Teale's, and the supra-condyloid method, the use of a full-sized scalpel for making the anterior flap may be employed conveniently, the ordinary amputation-knife being used for making the posterior flaps. Some surgeons prefer, in order to add a certain amount of brilliancy to the operation and save a few unimportant seconds, using one instrument throughout; but there is no special advantage to be gained by doing so. In forming a skin flap, as in Carden's operation, care should be taken not to keep the cutting edge of the knife towards the skin, as in an anatomical dissection. The danger of doing so is the liability of the flap to slough, arising from the nutrient vessels in the subcutaneous tissues being divided during the operation. Another important practical point to bear in mind is the necessity for holding the knife so that the edges of the skin shall not be bevelled, but divided perpendicularly. The dangers of sloughing will in this way be also diminished. On reaching the bone care should be taken to divide the periosteum with the knife, and not, as is so often done, with the saw. Neglect of this is apt to be followed by periostitis from the tearing or laceration of the membrane, an accident which in its turn is followed by necrosis at the extremity of the divided bone.

According to Von Langenbeck, Trélat, and others, the formation of periosteal flaps to cover the cut surface of the bone is believed to be attended with advantages. These are held to be that the periosteal curtain covering the medullary canal acts as a barrier against the introduction of septic agencies, and diminishes, consequently, the chances of the occurrence of osteo-myelitis. It can be done either by making a somewhat quadrilateral-shaped flap and letting it fall over the cut surface of the bone, or by the method of M. Trélat, which is to detach the membrane all round the bone for fully an inch below the point where the bone has to be divided, making thus a sleeve-shaped flap. The writer fails to recognise the advantages of either method.

The division of the bone should be made by a broad-bladed saw with finely-set teeth. The advantage of the broad blade is that it is much easier to make a plane, even section, and, in commencing it, by placing the left thumb-nail against the side of the blade, the operator can steady the instrument and prevent it getting out of the groove it makes in the first instance, in a manner hardly possible when any narrow-bladed instrument is employed. The operator should commence by laying the heel of the instrument on the bone, drawing it towards him to its full length, and complete the division, taking care to avoid too rapid an action of the instrument, as from the friction an amount of heat is generated which, it is alleged, may injuriously affect the bone. If the edges of the bone be sharp, and likely to exercise an injurious effect on the flap, bone-forceps can be employed to round them, and thus diminish the chances of ulceration from pressure.

All bleeding vessels having been secured by carbolised catgut, or other equally aseptic sutures, the wound should then be dressed. *See* Antiseptic Surgery. The writer, notwithstanding what has been said and written to the contrary, ventures to express his conviction and belief that rendering the atmosphere in which the operation is performed thoroughly aseptic, whether it be done by carbolised spray or other means, is of the first importance.

Another point in connection with the treatment of an amputation wound, which the writer would emphasize is the desirability of a free application of a zinc chloride solution (30 to 40 grs. ad aquæ f℥j.) to the wound, drainage, and taking care not to close the wound until all oozing has ceased ; the use of deep, as well as superficial, sutures, and externally the dressings of gauze treated with carbolic acid, eucalyptol, or corrosive sublimate ; or, again, wood wool or turf, similarly treated, the latter of which dressings, so much employed of late in Germany, give the best results.

In the performance of an amputation, the operator should have at least four assistants : one to anæsthetize the patient ; a second to command the hæmorrhage by tourniquet, digital pressure, or elastic bandage ; a third to retract the flaps and ligature vessels ; and a fourth to hand the instruments and other appliances.

The principles which should guide the surgeon in the treatment of amputations, and of all wounds, have been clearly and forcibly indicated by Esmarch in his paper 'Der Antiseptische Dauerverband,' read at the last meeting of the International Medical Congress at Copenhagen.

These may be briefly summarised as follows :—

I. Making the wound as thoroughly dry as possible by a complete arrest of all hæmorrhage.

II. By the introduction of deep sutures and elastic pressure externally, preventing cavities or open spaces existing within the flaps.

III. Giving free exit to all wound-secretion.

IV. Maintaining, by the most careful precautions, a thoroughly aseptic condition of the wound, and of everything in close proximity directly or indirectly connected with it.

V. Employing a dressing by which moderate pressure on the flaps can be made, and which can readily absorb all wound-secretion.

VI. Giving rest and fixation (*Immobilisirung*) to the part operated on.

William Stokes.

AMUSSAT'S OPERATION. *See* Colotomy.

AMYGDALITIS. *See* Tonsils.

AMYLOID DISEASE. *See* Albuminoid Degeneration.

ANÆSTHESIA.—The loss of sensation or of the sense of touch, whether from disease or injury : hence *local anæsthesia.* The term 'general anæsthesia' is usually applied to the state of unconsciousness produced by the administration of certain drugs known as anæsthetics.

ANÆSTHETICS.—Agents used for the suspension of sensation, and thus for the prevention of pain.

The chief use of anæsthetics in surgery is for the abolition of pain during operations ; but some anæsthetics are also used for preventing reflex movements and for producing muscular relaxation, and are thus valuable aids to diagnosis and treatment.

Anæsthetics are either *local*—i.e. acting only upon the part to which they are applied ; or *general*—i.e. rendering the person subjected to their influence entirely insensible.

Local anæsthesia is usually produced by the application of cold to the surface, whereby the part is sufficiently benumbed to admit of superficial operations of short duration being endured without pain. The most convenient method of freezing a part for operation is to direct upon it a finely divided spray of anhydrous ether. A portable spray-producer, which can be easily worked by the hand, is sold by the instrument-makers, and this being fitted to a small bottle containing the ether, a fine spray should be projected upon the part from a distance of about six inches, and with just sufficient rapidity to keep up a constant evaporation. The surface to be frozen should be dry, and the spray should be applied until the skin assumes a dead white colour, when it may be incised without pain.

It must be remembered that the vapour of ether is highly inflammable, so that the spray must not be used in conjunction with the actual cautery or in the neighbourhood of unprotected lights.

A similar degree of local anæsthesia may be produced by the use of a mixture of equal parts of pounded ice and common salt, which should be enclosed in a muslin bag, and kept upon the skin until the characteristic pallor is observed, which is usually in about five minutes.

This method can be applied to a somewhat larger surface than the ether-spray, but in either case the insensibility is but skin-deep, and lasts only a minute or two. This, however, is sufficient for a variety of small operations, such as opening an abscess, slitting up a sinus, or cutting off a pile; and, seeing that the chief pain of many more serious operations depends upon the incision through the skin, much suffering may be prevented by inducing local anæsthesia in cases in which, for any reason, the induction of general anæsthesia is undesirable. No harm results from such freezing, and the only inconvenience of the process is the toughness of the frozen tissues, which renders them more resistant to incision or dissection.

For producing anæsthesia of mucous surfaces, e.g. that of the eye or throat, the local application of a solution of muriate of cocaine has recently been used. A watery solution of 2 to 4 per cent. is suitable for use in operations upon the eye. A drop or two is applied to the inner surface of the lids three times at intervals of two minutes; in six or seven minutes the conjunctiva is sufficiently insensitive to allow of operations, such as that for squint or extraction of cataract, to be performed with little or no pain. Stronger solutions, as e.g. 20 per cent., may be used for painting over the laryngeal or other mucous surfaces, very decided temporary anæsthesia being thus produced.

General anæsthesia is obtained by the inhalation of certain vapours, which have the effect of producing insensibility without interfering with the essential vital functions.

The anæsthetics in common use are ether, chloroform, and nitrous oxide gas.

These differ materially both in their effects and in the mode of administration, so that it will be necessary to describe them separately, but there are some general principles which should be borne in mind in the administration of all anæsthetics.

In the first place there should be no impediment to free respiration, so that all tight clothing should be avoided, and the stomach should be empty. Whenever possible, the patient should be recumbent, and in an unrestrained and easy posture. Artificial teeth should be removed from the mouth, lest they become loose or displaced during insensibility. It is well also for the bladder to be emptied, since involuntary micturition is apt to occur.

The early morning, before breakfast, is as a rule the best time for taking anæsthetics, because abstinence from food is borne during sleep without inconvenience; and the rest of the night conduces to equanimity and calmness. The amount of an anæsthetic required to produce insensibility is in proportion to the quantity of blood in the person to whom it is administered. So that young children and anæmic persons require a proportionately smaller quantity than the full-grown and plethoric. Those addicted to alcohol or to much smoking take, as a rule, a large quantity of ether or chloroform; they usually struggle much, and are not good subjects for anæsthetics.

It is very desirable that the anæsthetic should be given by some one not concerned with the operation to be performed. so that his whole attention may be devoted to the maintenance of the proper degree of insensibility, and to the careful observation of the condition of the patient.

Ether.—This is at the present time the most generally used anæsthetic for operations of any considerable duration. It was the first anæsthetic systematically used for surgical purposes. But soon after the discovery of the method of so using it, and when the whole subject of artificially producing anæsthesia was in its infancy, chloroform was introduced and recommended by Sir James Simpson, as a more potent and convenient agent, and so, in Europe, ether for a time fell into disuse. In America, however, where it was first used, ether continued to be generally employed, and during the last ten years it has, in England, to a great extent taken the place of chloroform, on account of the general belief entertained of its greater safety. The greater safety of ether as compared with chloroform depends upon its stimulant effect upon the action of the heart.

The chief danger of chloroform is the possibility of its producing a sudden failure of the heart's action, and this danger does not pertain to ether. Ether, on the contrary, is a stimulant to the heart, and during inhalation of its vapour the pressure in the vessels is maintained, until there has been a manifest failure of the breathing.

This difference between the two drugs is of very great importance, because the failure of respiration, whilst the circulation is maintained, is a danger from which the patient may usually be recovered; but any considerable failure of the circulation involves the gravest peril.

Moreover, cardiac syncope is apt to occur with great suddenness, so that the absence of warning allows but little opportunity for averting the danger; whereas respiratory failure almost always takes place gradually, so that careful observation will generally lead to its recognition while it is still remediable.

Nevertheless, death has been known to result from the sudden failure of respiration, owing to the occurrence of an epileptiform spasm of the respiratory muscles, whereby the chest is fixed in the position of expiration. This is the only death from ether which the writer has witnessed during a large experience of its administration, both by himself and others; and unhappily nothing that was discovered, either at the time or at the post-mortem examination, gave any clue as to how the fatality could have been avoided.

Such cases are no doubt extremely rare, but they teach us that it cannot be rightly said that any anæsthetic is entirely free from danger. We can scarcely expect to render a person profoundly insensible without incurring some risk. This risk is certainly very small in the case of ether; but it is sufficient to point to the necessity of carefully watching the condition of everyone placed under the influence of an anæsthetic, and to deter the wise from the use of even the safest of these potent agents without due consideration and necessity.

In the administration of ether vapour for producing anæsthesia the chief precautions necessary to be observed are these:—

1. That kind of ether should be used which is fittest for the purpose of inhalation; and this is the pure anhydrous washed ether, of specific gravity ·720, free from alcohol and water. Methylated ether of sp. gr. ·735 answers perfectly well, however, and it is much cheaper and less volatile. The compounds sold as 'ether for local anæsthesia' are not suitable for inhalation.

2. The ether should be given in such a manner that the inhalation may be commenced with a very weak vapour, which, after a few inspirations, can be rapidly increased in strength. If we begin with too powerful a vapour the air-passages are intolerant of it, and the patient resists the inhalation; but, after a few moments' inhalation of a diluted vapour, its strength can be increased without inconvenience, and the patient rapidly brought under its influence.

3. Stimulants should not be administered before the inhalation. Ether is itself a stimulant, and can be safely given in cases where there is great depression or shock, but it is undesirable to have alcohol in the stomach when ether is being inhaled.

4. Whatever danger may belong to ether has relation to the respiratory function; the breathing should, therefore, be watched, and, should any embarrassment of this function arise, the inhalation should be stopped until the breathing is properly re-established. It is desirable so to place the head of the patient that the saliva (the secretion of which, as well as of the other glands of the mouth, is increased by the ether) may run out of the corner of the mouth rather than into the trachea.

Let it, above all, be remembered that, if any serious impediment to respiration occurs, the remedy which is, beyond all comparison with others, the most potent, is artificial respiration. The greatest care should of course be taken to ensure the absence of any mechanical obstruction to the free ingress of air to the lungs. The tongue should be pulled forcibly forwards and the finger passed to the back of the mouth, to ascertain that the passage is clear. But no time should be wasted in setting batteries to work, administering stimulants, or endeavouring to excite reflex movements. The important thing to be done is to at once commence artificial respiration, and, should air not then pass through the glottis, the windpipe should be opened without delay. Slighter disturbances of respiration may often be overcome by simply throwing back the head into the position of extension, and tilting forwards the chin. In other cases a little sticky mucus requires to be swept out of the back of the mouth with a sponge or towel. More serious obstruction may arise from vomited food lodging in the pharynx. It is always well, therefore, to have at hand a strong pair of flat-bladed forceps, with which the jaws can be opened and the tongue drawn forward, or any obstructing material seized.

In the absence of any special apparatus, ether may be easily administered by folding a towel into the form of a cone, into the apex of which is thrust a small sponge wrung out of hot water; about half-an-ounce of ether is poured on to the sponge and inner surface of the towel, which is then held over the patient's nose and mouth in such a way that (after the first minute, during which air is freely admitted) he breathes an atmosphere heavily charged with ether vapour, no more air being allowed to enter than can be drawn in through the apex of the cone or beneath the edge of the towel held firmly over the face. A fresh supply of ether must be frequently poured on to the sponge, for it evaporates quickly, but in this way insensibility can be produced in four or five minutes.

This, however, though an easily available method, is wasteful and disagreeable, for the ether is apt to run on to the patient's face, and much also escapes into the room. It is convenient, therefore, to use some one of the special forms of apparatus invented for the purpose.

A very simple one, introduced by the writer when he first advocated the use of ether, is a cone of thick felt covered with silk, between which and the felt is a layer of mackintosh cloth. The lower border of the felt is turned in to the extent of an inch, so as to make a thick soft edge to fit over the face, and to prevent the ether running on to the skin. The cone should be about eight inches high and its base four inches in diameter, and in its upper end should be placed a small soft sponge. Such cones can be made by anyone, are easily washed, and are very portable.

Improvements on these can, however, be obtained of the instrument-makers, of which the best are those invented by Mr. J. H. Morgan and the late Mr. Clover. Mr. Morgan's consists of a double cone, with valves so arranged that the expired air passes between the cones, and is carried to the floor by a tube. Mr. Clover's inhaler has an india-rubber bag communicating with the face-piece, and so connected with a vessel containing ether that the patient can be made to breathe, first the air in the bag, and then, gradually, air passed through the ether vessel, the strength of the vapour being modified by the amount of air passed through the ether.

The pleasantest and most rapid plan is to give first nitrous oxide gas to the stage of insensibility, and then to keep up the anæsthesia by ether. Mr. Clover invented an apparatus in which, by the turn of a valve, the vapour inhaled could be changed from laughing-gas to ether. The disadvantage of this method is the greater venous congestion which is thus produced.

The first effect of the inhalation of ether is a sensation of tingling and warmth throughout the body; the vapour is at first disagreeably pungent, and may excite cough; the air-passages, however, soon become accustomed to it, and the patient then breathes more deeply; after about two minutes sensation is much diminished and consciousness becomes clouded; then there often ensues a short period of struggling, which is succeeded by a gradual relaxation of the muscles and a condition of complete insensibility. When this is reached the eyelid may be raised and the conjunctiva touched with the finger without producing any movement of the lid. This, therefore, is a convenient test of the proper degree of anæsthesia having been attained.

Recovery from ether is sometimes characterised by a somewhat noisy or talkative stage of intoxication. It is well, therefore, to cover the eyes and encourage sleep. The taste of the ether is best got rid of by washing the mouth with warm water, in a tumbler of which a teaspoonful of eau de Cologne has been mixed.

Chloroform is doubtless a most convenient anæsthetic, and, in careful hands and with due precautions, may be given with very little danger. But it has the very great disadvantage that if given in too concentrated a vapour it is capable of producing a dangerous depression, or even a sudden arrest of the heart's action; a condition from which recovery is seldom possible, and which is responsible for the majority of the deaths that have occurred from chloroform inhalation. It would seem, moreover, that some persons are peculiarly susceptible to the action of chloroform upon the heart, so that to these even a small dose of the vapour may be dangerous. It is the opinion of the writer, therefore, that chloroform should only be used in cases to which, for some reason, ether is inapplicable.

For instance, the operation for cleft palate is much more conveniently performed under the influence of chloroform than of ether, because of the increased secretion of saliva and mucus which ether gives rise to, and the greater facility with which chloroform can be re-administered during the progress of the operation. Again the inflammable nature of ether vapour renders it under some circumstances inadmissible.

The chief care, then, in administering chloroform should be the avoidance of too concentrated a vapour, that is to say, of more than four per cent.; and this is to be attained either by using a vapour of measured strength, or by insuring the free access of air with the evaporated chloroform. By Clover's apparatus a mixture of chloroform and air is inhaled from a bag containing thirty-three minims of chloroform to each thousand cubic inches of air, so that a vapour of known and uniform strength is administered. A simpler, though of course less exact, method is to pour a drachm of chloroform upon a folded towel or handkerchief which is held over the patient's face loosely enough to allow air freely to mix with the evaporated chloroform. The patient should be brought gradually under the influence of the drug, by holding the cloth three or four inches from the face to begin with, and after a dozen inspirations, bringing it more closely over the mouth and nose. Twenty or thirty drops of chloroform are to be added from time to time as it evaporates.

Insensibility is produced in about five minutes, the same stages being passed through as with ether. The pulse and respiration should be watched, and on any failure of the pulse or obstruction of the respiration occurring, the chin should be thrown back and the tongue pulled forcibly forwards. Should this not suffice for recovery, artificial respiration should be at once resorted to. Especial care should be taken when the patient is struggling, lest, by a very deep inspiration and subsequent closure of the glottis, too much chloroform is suddenly absorbed into the blood.

Troublesome nausea and vomiting occasionally occur after taking chloroform, and less frequently, after ether. The best remedies are free ventilation of the room, maintenance of the recumbent posture, abstinence from food, iced water in teaspoonful doses.

Nitrous Oxide Gas.—This is an admirable anæsthetic for operations not lasting more than two or three minutes. It is very safe, not disagreeable, and is seldom followed by any discomfort.

It requires for its administration a special apparatus. This consists of an iron bottle containing the gas condensed into a liquid. An india-rubber tube is connected with the bottle, and by opening the communication, the gas escapes from the bottle into an elastic bag, from whence another tube conveys it to a face-piece through which it is inhaled. It is essential that the gas should be given pure and without the admixture of air, for such a mixture produces the exciting and intoxicating effects which gave it the name of 'laughing gas.' The margin of the face-piece must therefore be enclosed by an air-cushion, to ensure its fitting so accurately to the face that no air can enter.

The bag being filled with gas, the face-piece must be applied and pressed firmly to the sides of the nose and round the mouth; the patient is then directed to close the eyes and to take slow deep inspirations, the communication with the gas-bag being at first closed. Immediately after the first complete expiration the gas should be turned on to the face-piece, and thus, the lungs being emptied, a full dose of gas is at once inhaled, a gentle stream of gas being allowed to flow into the bag, so that respiration is carried on without effort. In about a minute the patient is insensible; the blood is darkened, the surface becomes extremely livid, the breathing stertorous, and slight convulsive movements occur; the eyelids are insensitive and the pupils dilated. The gas must now be removed and the operation at once proceeded with.

As soon as the gas is withdrawn, recovery begins, and at the end of two or three minutes the patient is quite himself again. If necessary, however, insensibility may be prolonged by removing the face-piece, admitting air for two inspirations and then again giving the gas, repeating such intermission from time to time when the breathing becomes stertorous. This should only be done, however, on emergency, for if longer anæsthesia is required it is better to supplement the gas with ether. Moreover the gas cannot be depended upon for producing perfect quietude; there are almost always slight jerky movements, and young people often pass into a condition of complete opisthotonos when deeply under its influence.

For operations upon the mouth, such as the extraction of teeth, it is necessary to prop open the jaws by a wedge fixed between the upper and lower teeth, before the inhalation of gas is commenced; otherwise the jaws would become tightly closed and access to the back of the mouth be prevented. Ordinarily, no disagreeable effects follow the inhalation, although vomiting is occasionally produced in pregnant women. Abstinence from food is of less consequence before inhaling gas than when other anæsthetics are to be taken, yet it is preferable that the stomach be empty, so that respiration may be as deep as possible. To take alcohol before inhaling the gas is dangerous.

Should faintness ensue, or any delay in recovery occur, the patient should be placed recumbent, and artificial respiration performed.

Other anæsthetic compounds have occasionally been used, which are mostly of unstable composition and less reliable than those above mentioned.

Bichloride of Methylene is a compound of chloroform which has been a good deal used in ophthalmic surgery, and by Sir Spencer Wells for ovariotomy and other abdominal operations. Very similar to this is a mixture of one part of alcohol, two of chloroform, and three of ether, which has been by some recommended. The instability of these compounds is objectionable, and they appear to possess no advantage over the other anæsthetics described in this article.

J. Warrington Haward.

ANALGESIA.—The loss of the sensation of local pain.

ANAPHRODISIA. *See* Impotence.

ANCHYLOSIS. *See* Ankylosis.

ANEURISM may be defined as a pulsating tumour in direct communication with an artery, since that is its condition when it comes before the surgeon for treatment, although under certain conditions an aneurism does not pulsate. The existence of an aneurism, apart from a wound of the vessel with which it is connected, presupposes disease of the arterial coats (*see* Arteries, Diseases of); for a healthy artery would not admit of dilatation sufficient to form a sac, nor would it give way under any reasonable exertion on the part of the patient. Given a diseased condition of the arterial coats, they may yield spontaneously to the pressure of the blood impelled forcibly against them, as in the transverse portion of the arch of the aorta; or may be stretched and weakened by the constant movement of a neighbouring joint, as in the case of the popliteal artery. In the great majority of aneurisms, however, there is a distinct starting-point of the disease connected with some strain or over-exertion, during which the patient is conscious of a crack or giving way of tissue, in the region where an aneurism subsequently shows itself.

The division of aneurisms into 'true' and 'false' is somewhat complicated by the different views held as to the use of those terms. The existence of any aneurism, in the walls of which all the coats of the artery are to be found is very doubtful, and for all practical purposes a 'true' aneurism may be defined as one in which the blood is contained within the arterial walls, however thin they may be; while a 'false' aneurism has its walls formed by condensation of the tissues surrounding the artery, and is therefore for the most part traumatic.

Aneurisms are rarely *fusiform* or formed by dilatation of the whole circumference of an artery, but are in the great majority of instances *sacculated*, there being a distinct pouch arising from one side of the artery having an aperture of communication with the interior of the vessel. It is by the gradual formation of this sac that the characteristic symptoms of aneurism are produced; and a fatal result is commonly due to rupture of the sac, either externally or internally, or to pressure upon vital parts by the increasing size of the tumour. Occasionally, in the case of the aorta, the coats of which are especially liable to atheroma, the blood finds its way between the middle and external coats of the vessel, splitting them asunder for some distance, and forming an elongated pouch or *dissecting* aneurism, which may or may not have a second communication with the interior of the artery.

As the result of a wound, or more rarely spontaneously, an aneurismal sac may form between an artery and a vein, forming an Arterio-Venous Aneurism.

Causes.—From what has been said it is obvious that the causes of aneurism are divisible into predisposing and active. Conditions of the system tending to arterial disease must conduce to aneurism, and foremost amongst these may be placed intemperance and syphilis. The undoubtedly greater liability of men over women to suffer from aneurism is partly to be explained by the greater prevalence of chronic intemperance and of constitutional syphilis among the former; and partly by the greater physical exertion which the male sex is liable to in various employments. This is especially seen in the case of soldiers, who, besides being the subjects of intemperance and syphilis, are often called upon to make violent exertions, suddenly, under very unfavourable circumstances as regards their clothing. The tight uniforms and rigid stocks of former years had much to answer for in the production of thoracic aneurism, and the lightly clad sailor, though probably equally diseased, has been found to be much less liable to that disorder than the soldier. Obstruction of an artery by its being plugged with an *embolon* or some vegetation loosened from one of the valves of the heart is undoubtedly a cause of aneurism of the smaller arteries, particularly in the brain or the branches of the external carotid. This may occur in young persons, but as a rule true aneurism is a disease of middle life, when the atheromatous changes in the arterial walls are progressive; whilst false aneurism is more likely to occur spontaneously in more advanced years, when the walls of the arteries have become calcareous and brittle, and are therefore liable to rupture on sudden exertion.

Symptoms.—The symptoms of an aneurism in a limb are fairly obvious, the pulsating swelling usually first attracting the patient's notice; but this may come on so insidiously that popliteal aneurisms have often been found, accidentally, in a patient previously unaware of the existence of any swelling. The distinct *pulsation* of a swelling in the position of a main artery at once raising the question of aneurism, its direct communication with the vessel should be ascertained by making pressure upon the artery nearer the heart, when all pulsation in the tumour should abruptly cease. Now, gently grasping the tumour with his hand the surgeon slightly compresses it, and on relaxing his hold of the artery above is at once conscious of the *distensile expansion* characteristic of aneurism; for although in rare cases of cancer a tumour may, after compression, become distended with blood and eventually pulsate, the time thus occupied is much longer than in true aneurism. The ear or a stethoscope applied to the tumour will now, in the great majority of aneurisms, detect a distinct *bruit*, synchronous with the pulse in a healthy limb, and it is hardly possible to confuse this with the much feebler sound produced by mere pressure on a superficial artery with the edge of a stethoscope.

In internal aneurisms the effects of the pressure of the sac upon important structures must often precede the appearance of any tumour externally. Hence *pain*, which is often by no means marked in aneurisms of the limbs, is a constant and early symptom in internal aneurisms, whether of the chest or abdomen. The pain being due to pressure upon the trunks of nerves is reflected to their peripheries; thus, intercostal pain may be caused by an aneurism of the thoracic aorta, and pain down the thigh by iliac aneurism. In the case of aneurism of the arch of the aorta or of its primary branches, pressure-effects upon the function of important nerves are often well-marked; thus aphonia, from pressure on one recurrent laryngeal nerve with corresponding paralysis of the laryngeal muscles, is frequently met with; or dyspnœa from spasm of the laryngeal muscles due to irritation of the pneumogastric trunk. The mechanical effects of the pressure of an aneurism upon the blood-vessels and other structures is also commonly seen in enlargement of the superficial veins of the thorax and abdomen or in œdema of the limbs, and in the dyspnœa and dysphagia caused by pressure upon the trachea or bronchus and upon the œsophagus.

The effect of dilatation of an artery is to diminish the force of the pulse beyond. Hence the pulse in an aneurismal artery is smaller than in the healthy limb, and this is usually perceptible to the finger, but may be more thoroughly appreciated by the use of the sphygmograph, the tracing of the aneurismal artery having for the most part lost the abrupt rise and fall of health, and being rounded in form.

Diagnosis.—In the majority of external aneurisms the diagnosis is easy, whilst in internal aneurisms it is always more or less obscure, both as to the nature of the tumour and the vessel involved. There are, however, certain fallacies in external aneurisms to be guarded against, and these are to be avoided mainly by attention to the symptoms detailed above. (1) An abscess or any cyst, in close relation with an artery, may have pulsation so transmitted to it as to cause it to resemble an aneurism; but the pulsation is not expansile, there is no *bruit*, and the history is not that of aneurism. (2) An artery may be so raised by any tumour beneath it as to resemble an aneurism, and the pressure may produce a spurious *bruit*; but the pulsation will be found to exist only in the line of the vessel, to be non-expansile, and to diminish rather than to increase with the growth of the swelling. (3) A soft malignant tumour, usually connected with bone, may pulsate and even have a *bruit*; but its size can be in no way influenced by pressure on the main trunk, although it may cease to pulsate, and when emptied by manipulation it refills more slowly and with a gradually increasing force of impulse, quite unlike that of an aneurism.

Aneurisms may have *ceased to pulsate* from having become consolidated, i.e. cured; or from having given way and become diffused. The first condition is obviously one of no urgency, and time will show that the tumour is decreasing rather than increasing in size. The second is usually accompanied by such marked symptoms as to be unmistakable.

The giving way of an aneurism externally or into an internal cavity is a necessarily fatal event, marked by sudden faintness and death-pallor; but an aneurism giving way into the tissues of a limb, though sufficiently serious, is amenable to treatment. The symptoms of shock, the sensation of something giving way, and the swollen condition of the limb, which is cold and in which no pulsation is to be detected, sufficiently mark the occurrence. If the extravasation of blood is small it may so compress the aneurism as to induce spontaneous cure, but if large it will almost certainly induce gangrene of the limb, with probably septicæmia and death. The treatment must necessarily at first be expectant, the limb being elevated to favour the return of venous blood, and its temperature being maintained without being unduly raised. Should no symptoms of gangrene supervene, the careful support of the tissues by bandaging, and the observance of complete rest until all the extravasated blood is absorbed, will alone be required to complete the cure, which must necessarily be a tedious one. When, however, gangrene shows itself, there should be no hesitation in amputating promptly above the aneurism, as the best means of saving the patient's life. There is a certain small number of recorded cases in which ligature of the main artery above a ruptured aneurism has been followed by recovery, with or without amputation; but these are more than counterbalanced by the very large number of cases in which a fatal event has followed the operation. The probability is, that the cases which survive ligature of the main artery without amputation would have recovered equally without any operation at all.

Prognosis.—The tendency of all aneurisms is to increase in size with thinning of the wall at some point where resistance is weakened. Hence, internal aneurisms tend to burst into serous cavities or into mucous canals, whilst external aneurisms cause absorption of overlying structures by their pressure, and eventually burst by ulceration of the skin, or become diffused beneath the integuments. Occasionally, no doubt, under favourable circumstances, an aneurism may become cured spontaneously, or, at least, may cease to increase in size and become solidified by deposit of laminated fibrine upon the wall of the sac. Such a result cannot be counted upon, and a patient the subject of aneurism must be made to appreciate the extreme gravity of his condition and the necessity for submission to appropriate treatment.

Cure.—The mode of cure of aneurism was until recently believed to be, in all cases, the slow deposit of laminated fibrine, which is known to occur spontaneously in the sacs of aortic aneurisms. But it has of late been shown that coagulation of the contents of an aneurism may occur both accidentally and as the result of treatment, and that it probably occurs to some extent in all cases, whether a previous deposit of laminated fibrine has taken place or not. In the great majority of cases this mode of cure causes an obstruction of the calibre of the artery, which thereupon ceases to pulsate, but there are a few examples of cured aneurisms in which pulsation of the main artery has continued unimpeded. This can, of course, only occur in well-marked sacculated aneurisms.

Treatment.—(1) *General.* — The most important element in the treatment of all aneurisms is Rest. It is not only that rest will give the best opportunity for the deposit of fibrine and the coagulation of the diminished contents of the sac, but that rest is essential to diminish the force of the circulation and prevent the washing away of coagulum already formed. A patient suffering only from an external aneurism should be kept in bed for a day or two before active surgical treatment is begun. Diet is the next most important element, and should be limited in quantity and carefully regulated as to quality, the object being to favour the coagulation of the blood without stimulating the heart. About ten ounces of solid food, composed of well-cooked meat and biscuit, with half a pint of milk and no stimulants, may be taken as a standard dietary, but many patients cannot bear so low a scale. As regards medicines all that can be said is, that there are many drugs that have a reputation which they do not appear to deserve, as adjuvants in the treatment of aneurism. First, and probably oldest, is Digitalis, by which undoubtedly the action of the heart may be depressed, but with increase of arterial tension. Iron has been held to improve the quality of the blood and favour coagulation. Iodide of potassium and Acetate of lead have been thought to be beneficial, but with doubtful effect; and Ergotine has been injected subcutaneously on the theoretical view of contracting the muscular coat of the aneurism, which has little or no existence. Sedative medicines, such as Morphia, Indian hemp, and Bromide of potassium, are undoubtedly of service in calming the nervous system, relieving pain, and favouring that equable condition of the circulation which is most likely to induce coagulation of the contents of an aneurismal sac.

(2) *Local.* —*Pressure* is the treatment most immediately indicated in the case of aneurisms of the limbs, where the main artery can be controlled on the proximal side of the sac. With the older view of the method of cure before them, and with the successful practice of the Dublin hospitals to support it, surgeons were until recently in the habit of resorting to mechanical means of modifying, rather than of arresting, the flow of blood through the main artery of a limb. Two of Signoroni's tourniquets, or the more elaborate apparatus of Carte, were applied over the femoral artery, and were regulated so as to allow of a flow of blood through a popliteal aneurism sufficient to give slight pulsation in the sac. Applied in this way for twelve or fourteen hours, a cure is sometimes, no doubt,

promptly effected; but in the majority of cases it is necessary to remove the instruments in order to allow of the patient sleeping, and to resume the treatment on the following and perhaps for several consecutive days, before a cure is effected, if at all.

Digital pressure by the fingers of assistants, aided by the use of a heavy weight to relieve their muscular strain, is a more efficient method, and may be adopted either after the employment of instrumental pressure or alone. In this case the circulation through the main artery is completely stopped, and presumably the blood in the aneurism is at rest and in a condition favourable for coagulation. Certainly many cases are now on record, in which complete cure of popliteal aneurism has been effected by digital compression in from seven to ten hours.

Local pressure upon the sac of an aneurism must be of very limited application, from the risk of bursting the sac. Mr. Holmes has recorded a case of subclavian aneurism in which benefit was derived from the pressure of an india-rubber air-ball bandaged into the posterior triangle of the neck; and the method of *flexion* of the knee, recommended for the treatment of popliteal aneurism by Mr. Hart, necessitates some pressure of the sac and through it of the artery. *See* POPLITEAL ANEURISM.

Rapid pressure—i.e. the complete arrest of the circulation through the sac of an aneurism for a limited time under the influence of an anæsthetic—was first successfully employed by Dr. Murray, of Newcastle, in a case of abdominal aneurism. *See* ABDOMINAL ANEURISM. The more modern method adopted in the case of the limbs, is Dr. John Reid's application of Esmarch's elastic band and tourniquet to secure complete stagnation of the blood, in both the arteries and veins of a limb, whilst coagulation of the contents of the sac of the aneurism is going on. In employing the method with Esmarch's bandage the writer thinks it essential that the sac should be full of blood; and he therefore recommends that the elastic bandage should be applied from below upwards and also from above down to the sac, in addition to the application of the elastic cord. By this plan the sac is rendered tense, the best proof of which is the production of slight subcutaneous ecchymoses, and coagulation of the contents is materially assisted. There is undoubtedly a risk of gangrene in this method which ordinary digital and instrumental pressure do not involve, and its use should be confined to the cases of small aneurisms in young subjects. *See* POPLITEAL ANEURISM.

The time during which stagnation of the blood in a limb may be safely kept up cannot be accurately ascertained, but the writer has maintained it for three and three and a-half hours respectively, without bad result and with complete cure of popliteal aneurisms. Less than two hours cannot be expected to cure the aneurism, and in any case it is advisable to moderate the flow of blood through the artery by means of a screw tourniquet, for some hours after removal of Esmarch's apparatus, lest the soft and recent coagulum should be displaced and the cure be undone.

The Ligature, applied to the main artery of the limb in which an aneurism is situate, is the most efficient way of applying pressure to the vessel and of producing coagulation of the contents of the sac.

The Hunterian operation, in which a ligature is applied on the proximal side of the sac, but at some distance from it, and with one or more branches intervening to carry on the collateral circulation, is of universal application in the case of the limbs. The distance from the aneurism secures, in the great majority of cases, a healthy vessel, and the application of a ligature, whether of hemp, silk, or catgut (*see* LIGATURES), leads, as a rule, to permanent obliteration of the artery at that spot. The immediate effect of tying the main artery is to lower the temperature of the limb and to arrest pulsation in the aneurism, which becomes less tense than before. The sac is not emptied, however, and care should be taken that it is not over-manipulated at the time of the operation, lest the sac should be burst if thin, or be irritated so as to become inflamed. In all cases in which, after ligature, blood is left in the sac, it no doubt coagulates; and these are the cases in which pulsation does not recur, and in which a cure is rapidly and easily produced. In other cases, especially where the aneurism partakes of the fusiform rather than the saccular form, there is little if any coagulum, and cure is brought about later on by deposit of fibrine from the collateral circulation, aided, probably, at the last moment, by coagulation of the small central channel of blood. In these cases a pulsation may be detected in the sac in from twelve to thirty-six hours, at first very feeble, then becoming more forcible, and finally dying away again with permanent consolidation of the sac. But occasionally, and particularly in patients who have been submitted to prolonged compression-treatment unsuccessfully, the collateral circulation is so enlarged that pulsation returns very shortly after ligature, and persists until the aneurism is found to pulsate as forcibly as before the operation. Under these untoward circumstances recourse must be had to pressure both on the sac and below the seat of ligature, and probably the careful application of Esmarch's bandage offers as good a prospect of cure as any plan of treatment. Failing thus to effect consolidation, should the sac begin to increase and threaten to burst, the surgeon had better resort to amputation between the aneurism and the seat of ligature.

Giving way of the sac of an aneurism may follow immediately upon the operation of applying a ligature to the main artery, and is then due to the over-manipulation of an already attenuated sac; or may occur at a later date from inflammation of the sac with suppuration of its contents. In these cases all will depend upon the condition of the contents of the aneurism. If the extravasation occurs immediately after the application of the ligature, gangrene is almost certain to supervene and necessitate amputation; but if the contents of the sac have already become consolidated, suppuration may occur and matter may be evacuated, with complete recovery, although with considerable risk of the occurrence of secondary hæmorrhage.

Gangrene of the limb may follow the application of a ligature for the treatment of aneurism, and may be moist or dry. *See* GANGRENE. The latter form, depending simply upon insufficient supply of arterial blood, shows itself first in the toes, which become dark and shrivelled, and may eventually be removed, leaving a very useful limb. The moist variety, depending upon obstruction of the venous circulation due either to pressure of the aneurism or some interference with the main vein at the seat of the operation, is a much more serious affection, involving the whole limb, and exposing the patient to great risk of the occurrence of septicæmia. Early amputation above the aneurism offers the best chance of saving the patient's life.

Temporary ligature.—Attempts have been made from time to time to apply ligatures temporarily to a main artery, and various contrivances have been invented with this object in view but have all fallen into disuse. The catgut ligature of Lister and the flat ox-aorta ligature of Barwell are to a certain extent temporary ligatures, and the former has on more than one occasion disappeared too rapidly for a cure of the aneurism to be effected. *See* LIGATURES.

Distal Ligature.—In the case of aneurism of the arch of the aorta and its primary branches, the practice of applying a distal ligature to one or more of the great vessels has met with a fair amount of success. The original proposal of Brasdor was, to place a ligature beyond an aneurism in cases in which deligation on the proximal side was impossible; but it was left to Wardrop to bring the method to the test of practice, by tying the common carotid for carotid aneurism low down (1825). Subsequently Wardrop extended the practice to the subclavian artery, which he tied successfully for innominate aneurism (1827), thus showing that the presence of large branches between the aneurism and the seat of ligature was no bar to the proceeding. Consecutive ligation of the carotid and subclavian for innominate aneurism was undertaken by Fearn, of Derby (1836–38), with success; and simultaneous deligation of the two vessels, for aneurism which proved to be aortic, by Hobart (1839), unsuccessfully, and for innominate aneurism, also unsuccessfully, by Rossi (1843). In 1865 the writer revived the practice by successfully tying the carotid and subclavian in a case of aneurism, supposed to be innominate, but which proved to be aortic upon the death of the patient four years later; and his example has been followed by other surgeons, and notably by Mr. Barwell, who also, in 1879, first employed the double distal ligature in a case of aneurism, diagnosed as aortic. In 1872, upon the suggestion of Dr. Cockle, the writer tied the left carotid in a case of pure aortic aneurism, with great relief to the patient, who survived four years and a half, and the operation has been repeated a few times with encouraging results. *See* AORTIC ANEURISM; INNOMINATE ANEURISM.

There has thus, within the last twenty years, been accumulated a good deal of experience as to the applicability of the distal ligature under various conditions, and on the whole the experience is encouraging. At the same time it is not easy to explain the *rationale* of the treatment. Brasdor's original view, that, by obstructing the vessels, coagulation of the contents of the sac might be induced, can only apply to the case where no branches intervene, and Mr. Holmes' suggestion that coagulation spreads backwards from the seat of ligature is not supported by facts. Wardrop's idea also, that cutting off from the aneurism the exit of two-thirds of the blood passing into it tends to cause coagulation of the other third is hardly tenable, since the full quantity finds its way into the sac as before. It appears to the writer that the most reasonable explanation is that the *direction* of the current of the blood in the sac being probably modified by the application of a distal ligature, there is a greater tendency for it to deposit fibrine than before, and thus to fill up the cavity. It must be admitted, however, that this theory is purely speculative.

Allied to distal ligature are two methods of treatment of aneurism suggested by Sir W. Fergusson. By *manipulation*, or handling of an aneurismal sac, that surgeon proposed to produce an artificial embolism of the artery beyond, and succeeded to a certain extent, in two cases of innominate aneurism, but with the drawback of producing head-symptoms, from embolism of the cerebral arteries. The other proposal was, in desperate cases of subclavian aneurism, to amputate it at the shoulder-joint, and thus perform distal ligature. The writer, having witnessed Sir W. Fergusson's original operations of manipulation, and having, on one occasion, employed the method by amputation, cannot recommend either for adoption.

The treatment hitherto considered has dealt mainly with the artery in which the aneurism is situated; but in cases which have resisted that form of treatment, attempts have been made from time to time to attack the contents of the sac itself. The *injection* of coagulating fluids, and especially of a solution of perchloride of iron, has been tried in a few cases with negative or disastrous results from embolism. The *introduction* of fine needles, in order to entangle fibrine has been tried with some benefit (*see* ACUPUNCTURE), and the same may be said of the addition of a *galvanic current*. *See* ELECTROLYSIS. The introduction of iron wire and of horsehair into an aneurism, with the view of entangling clot, need only be mentioned as having been tried unsuccessfully.

TRAUMATIC ANEURISM is the result of a puncture or rupture of an artery occurring some time before, the blood being enclosed in a cavity formed by the surrounding structures, and the external wound, if any, being generally healed. Pulsation will be present both in the tumour and in the artery below it, and a very loud *bruit* is generally to be heard over the swelling. If small, traumatic aneurisms are no doubt amenable to treatment by perfect rest and carefully adapted pressure over the tumour; but if of large size when first seen, or rapidly increasing in size, prompt surgical interference will be required. The *treatment* is the same as for a wounded artery, viz., to tie the artery above and below the injured spot; but this operation is rendered much more difficult than in the case of a recently wounded artery by the presence of a distinct sac containing clot and overlying the artery involved. The main danger is hæmorrhage, and in the case of the limbs this can be best guarded against by employing Esmarch's bandage (*see* ESMARCH'S BLOODLESS METHOD), and a good screw-tourniquet, so as to render the parts bloodless whilst the operation is being performed. If this is impossible, as in the case of the iliac or axillary artery, digital pressure on the main artery must be made, and the operator must be prepared to thrust his finger into the opening in the wounded artery and to plug it whilst operating with the other hand.

The sac being laid open by a free incision, the clot is to be rapidly turned out, and if there is hæmorrhage it must be at once arrested. The operator has now to dissect or scratch through the wall of the sac immediately above and below the aperture of communication with the artery, in order to pass two ligatures around the vessel and thus secure it. If there is no hæmorrhage it will greatly facilitate this part of the proceeding to introduce a good-sized bougie or catheter into the artery, so as to gain an idea of its position and depth. A very cautious dissection being then made through the sac of the aneurism half-an-inch above the opening, an aneurism-needle is carried round the artery distended by the bougie, which is then withdrawn, and the ligature is tied. The same steps are repeated below the opening. If, on relaxing the tourniquet, there is no bleeding, the operation is completed; but if there is, search must be made for the bleeding spot and the vessel must be secured.

The term *diffuse traumatic aneurism* is sometimes erroneously applied to cases of recent wound or rupture of a large artery, in which a large quantity of clotted blood is extravasated into the tissues of the limb. There will be found no pulsation in the swelling or in the arteries below the seat of the injury, and the whole limb is cold and congested. The treatment is the same as that described above, but the operation will be easier because the wounded or ruptured artery will be more readily found. At the same time the damage done to the soft structures is so great that the propriety of amputation must always be considered, particularly if there is reason to suspect that a ruptured artery has communicated with the cavity of a large joint, or if the main vein is found also to be torn. *See* ARTERIES, Rupture and Wounds of.

CHRISTOPHER HEATH.

ANGEIECTASIS. *See* LYMPHANGITIS.

ANGEIOLEUCITIS. *See* LYMPHANGITIS.

ANGEIOMA. *See* NÆVUS.

ANGULAR CURVATURE. *See* CARIES OF THE SPINE.

ANIMAL POISONS. *See* GLANDERS; HYDROPHOBIA; MALIGNANT PUSTULE, &c.

ANKLE, Dislocations at the.—Dislocations at the ankle-joint are five in number, viz. outwards, inwards, backwards, forwards, and upwards. These directions apply to the position of the foot, which, being farther from the centre of the body than the tibia, is regarded as the part dislocated. Astley Cooper, Malgaigne, and some others have spoken of the tibia as the bone displaced, and with some reason, inasmuch as the foot is usually fixed on the ground before the ligaments yield and allow the tibia to be displaced from its position. But it is more convenient to regard the foot as the part dislocated.

Dislocations at the ankle are more frequently partial than complete, it being comparatively seldom that the articular surface of the tibia is completely separated from that of the astragalus. When this does happen, the dislocation is usually compound. The partial lateral dislocations result from rotations of the foot upon an antero-posterior axis. The ligaments on one side are thus torn through, and the joint-surfaces gape on the same side. Further, dislocations of the ankle-joint are peculiar, in that they are usually associated with fracture, the fibula frequently, and the tibia sometimes, giving way under the force producing the displacement.

DISLOCATION OUTWARDS.—Partial dislocation of the foot outwards, with fracture through the lower third of the fibula, is by far the most common dislocation of the ankle-joint, and is often spoken of as Pott's fracture. It is occasioned by forcible abduction of the foot, and often results from simple falls in the street, such as may happen in slipping from the kerbstone. The weight of the body is suddenly directed through the inner ankle, and, as a consequence, the internal lateral ligament gives way, or the tip of the inner malleolus is broken off; the outer surface of the astragalus then bears heavily upon the outer malleolus, and the fibula is fractured from two to three inches above the articular surface of that process. After fracture of the fibula, the fractured end falls in towards the tibia, and the malleolus becomes everted. Thus is produced, to use Pott's own words, 'a perfect fracture and a partial dislocation.' The clinical signs are, eversion of the foot, prominence of the internal malleolus, and a depression on the outer side of the leg corresponding to the fracture of the fibula, at which point crepitus may be elicited on manipulation. Blood-extravasation, and swelling from intra-articular effusion, rapidly follow.

Rupture of the internal lateral ligament, or fracture of the internal malleolus, and fracture of the fibula, are the only pathological lesions usually admitted to occur in Pott's fracture; but the increased width between the malleoli, often noticeable, suggests something more, either rupture of some of the ligamentous connections between the outer malleolus and tibia, or a splitting off of a portion of tibia with the outer malleolus. This almost vertical fracture of the tibia was found to have occurred in two cases which the writer has had the opportunity of dissecting. It commences at the outer part of the articular surface of the tibia, and appears on the outer surface of that bone above the interosseous tibio-fibular ligaments. One of the cases alluded to was a recent case, the patient having died of more serious injuries; the other was a case in which the deformity had remained permanent, and had necessitated the wearing of an iron support. The latter case was examined fourteen years after the injury, and the line of fracture could still be traced. Moreover, the fibula below was found firmly ankylosed to the tibia by bony outgrowths, showing that nothing short of osteotomy could have corrected the deformity after reparation had taken place. It is probable that this fracture of the tibia may occasionally give rise to difficulty in reducing the dislocation, and the prolonged convalescence often noticed after Pott's fracture may be due to the fracture into the joint.

When the dislocation of the foot is complete, the lower end of the tibia usually bursts through the skin on the inner side of the ankle, and the dislocation thus becomes compound; but the writer has himself seen the foot thrust out at right angles to the leg without this accident occurring; and it is even said that complete simple dislocation outwards has occurred without fracture of the fibula.

The *reduction* is usually easy. The leg is placed at right angles to the thigh, to relax the gastrocnemius muscle; one hand then presses the tibia outwards, whilst the other is used to draw the foot inwards. It is unusual to find any obstacle to reduction. The deformity having been overcome, the limb may be put up in three splints as in ordinary fractures of the leg, but the outer splint should have its foot-piece thickly padded to press the foot inwards, and the inner splint should be so padded as to press the tibia out.

Dislocation Inwards, though next in frequency to dislocation outwards, is nevertheless a rare accident, and, since greater violence is required to produce it, is more serious. This dislocation is caused by a fall on the outer side of the foot, or by a cart-wheel passing over the ankle. The foot is thrown inwards, whilst the outer malleolus projects prominently beneath the skin, and the foot and toes point downwards. The inner malleolus, against which the astragalus is driven, is split off from the shaft of the tibia in an upward and inward direction, and the astragalus itself may sometimes be fractured. The outer malleolus may also be fractured, or its ligaments torn through.

Reduction is made by first flexing the leg on the thigh, then making extension on the heel and instep whilst pressing the foot outwards. After reduction, Astley Cooper recommends that the leg be laid upon an outside splint, which is padded so as to press on the fibula above the malleolus, and relieve the skin over that process from injurious contact. It may be more conveniently swung in three splints, taking care to prevent recurrence of the deformity by arranging the pads in such a way as to keep the foot straight and at right angles to the leg. The limb should be taken down and passive movement be commenced about six weeks after the injury.

Dislocation Backwards gives rise to an appearance of shortening of the foot, whilst the heel is unduly prominent behind, and the hollow spaces in front of the tendo Achillis are exaggerated. The tibia forms a firm projection beneath the anterior tendons, which are tense, and the toes are pointed downwards. It may be caused, like sub-astragaloid luxations and dislocation of the astragalus forwards, by over-extension of the foot on the leg, or by stepping from a vehicle in rapid motion. The dislocation backwards may be partial or complete. In the former case, the tibia rests partly on the articular surface and partly over the head of the astragalus and the scaphoid. When complete, the tibia passes forward and rests over the navicular and cuneiform bones. According to Hamilton, a partial dislocation may be consecutive to severe sprain and fracture of fibula, being brought about by the action of the muscles of the calf, but such cases should be regarded with some suspicion, as the great swelling present after these severe injuries may readily obscure, at first, a partial displacement. Whilst the tibia passes forward over the scaphoid, the fibula gives way above the malleolus, and this process is retained in its normal relation to the tarsus by its three strong ligaments. In a case dissected by the writer the extreme posterior edge of the articular surface of the tibia was found chipped off. The malleolus of the tibia may also be found broken.

To *reduce* this dislocation the leg should be flexed, and the heel being drawn forward by one hand, the other is used to press the tibia back into position. Should difficulty be experienced, the tendo Achillis may be divided. Though little difficulty has been met with in reducing the dislocation, there is in this form a tendency to reluxation, which must be guarded against. Pressure, directed so as to push the os calcis forward and the tibia backward, at once suggests itself, but, if attempted, must be carried out with the greatest caution, as both these bones are subcutaneous, and sloughing of the skin is likely to follow any but the gentlest pressure. It might be done with hollowed layers of thick felt plaster.

Dislocation Forwards causes lengthening of the foot and diminished prominence of the heel. At the same time, the leg is somewhat shortened, and the malleoli will be found lower than normal. The depressions in front of the tendo Achillis are filled by the displaced tibia, and in front of the joint the trochlear surface of the astragalus may be felt. It is a very rare injury, there being only six cases on record. Extreme flexion of the foot on the leg appears to be the primary cause, which is usually aided by some additional force applied over the tibia. Great difficulty has been experienced in attempts to reduce this dislocation, but a case recorded by Poland, in the Guy's Hospital Reports for 1855, seems to indicate that division of the tendo Achillis is what is required in order to effect reduction.

Before this was done, all attempts, even under chloroform, had failed. After reduction, the limb should be secured on a back splint with a footpiece, and there should be a hole in the splint large enough to receive the heel, so that it nowhere rests on the wood.

Dislocation Upwards, which is sometimes called 'Nélaton's dislocation,' is usually caused by a fall from a height on to the sole of the foot. Two cases have been described by Fergusson, and one by De Morgan; two, also, are mentioned by Bryant, one of which was double. In this injury the fibula is forcibly detached from its connections with the tibia, and the astragalus is driven up like a wedge between them. The inner malleolus and articular end of the tibia form a very prominent swelling, tightly stretching the skin on the inner side. The foot is usually everted, and the malleoli approach the ground, so that the limb is shortened. Reduction has generally been effected by extension, but in some cases all attempts to restore the parts to their normal positions have failed. The leg being flexed on the thigh, and held by an assistant, the surgeon should seize the instep and heel and attempt, by extension and to-and-fro movements, to disengage the astragalus. When reduced no tendency to reluxation has been noticed. Should the means described fail to reduce the dislocation, it may be justifiable to place a loop over the heel and instep, and make gradual extension by means of pulleys. But great care should be taken not to damage the soft parts and so occasion sloughing. When reduced, the limb should be secured between two side splints, and be thus retained for three weeks or a month, when passive movements may be commenced.

Compound Dislocation of the Ankle-Joint is a very serious injury, but not one by any means of necessity requiring amputation. Amputation is indicated when the dislocation is accompanied by much crushing or laceration of the soft parts, and distinct splitting of bone. It is required especially in cases caused by heavy wheels passing over the joint, and, less often, in those resulting from violent strains. The age and constitution of the patient should also be taken into consideration; for delicate and aged persons may succumb under the suppuration an attempt to save the foot may subject them to. Excision of the joint is suggested when there is a large opening freely exposing the articular surfaces, and when the bone protrudes through an opening too small to allow of its being reduced. In the latter case, many surgeons would be content to saw off only such an amount of bone as would allow of reduction. At the ankle the malleoli are apt to interfere with drainage, and the removal of the protruding process provides for this important aid to recovery; but it should be remembered that after removal of the external malleolus there is a tendency to abduction of the foot. In the simplest cases, where the wound is small, the dislocation may often be converted into a simple one by closing the wound at once with a pad soaked in compound tincture of benzoin, which forms, with the blood oozing from the wound, a firm antiseptic covering. The limb may then be fixed on a back splint with a footpiece, and an ice-bag be applied over the joint. Should suppuration follow, the pad must be removed, free exit allowed for pus, and drainage be maintained till the discharge lessens or ceases. In more severe cases the surfaces of the wound should be carefully cleansed with carbolic lotion, any bleeding vessel should be secured by torsion or catgut ligature, tendons drawn out and ruptured should be cut short, and any loose pieces of bone be removed from the joint.

The wound having been placed in the most favourable conditions for recovery, and the dislocation reduced, the foot must be maintained upon a splint at a right angle to the leg; for should ankylosis take place with the foot in an extended position, the limb will be of little service. The splints usually employed are a wooden back splint and two side splints, interrupted opposite the ankle to allow the dressings to be applied. But, in the writer's opinion, a better splint is a simple iron one, such as he is in the habit of using for excision of the ankle. It consists of a thin iron plate, hollowed to receive the leg, and its continuation is looped under the heel (at such a distance as to allow the antiseptic dressings to be wrapped all round), and then carried up as a footpiece to support the sole. It is covered with wax lint, and, the limb being secured in it by means of waxed bandages, no change in position need be made for months, or until ankylosis is complete. The judgment of the surgeon having been given in the first instance in favour of an attempt to save the limb, subsequent sloughing, extensive suppuration followed by exhaustion, or secondary hæmorrhage may compel him to reconsider his opinion, and induce him to perform a secondary amputation in order to save his patient's life. R. Clement Lucas.

ANKLE, Excision of the.—*See* Joints, Excision of.

ANKLE-JOINT, Amputation at the. Various methods have been proposed for the performance of this operation—the circular incision; the long dorsal flap method (Baudens); lateral flaps; and the single internal lateral flap operation (Roux, Sédillot, Mackenzie). Owing, however, mainly to the delicacy and thinness of the flaps, and as a rule the unfavourable situation of the cicatrix, these procedures have failed to bear the test of experience, and have been altogether superseded by the mode suggested by Professor Syme in 1843. This operation is undoubtedly one of the most important of the many surgical procedures associated with the name of that surgeon. The results, as shown by statistics, leave no doubt as to its merit and comparative freedom from risk; and the writer is of opinion that the so-called improvements and modifications which have been proposed should be rejected.

SYME'S OPERATION — one indicated, in the great majority of instances, in cases of tarsal caries—may be thus performed. Provision being made for the prevention of hæmorrhage, which can best be accomplished by Esmarch's elastic bandage, the patient should be placed on a table, with the condemned foot overhanging it. An assistant should then forcibly flex the foot upon the leg, and the operator, fixing the foot with his left hand, which he places behind the heel, and with his index finger and thumb on the points between which the incision should be made—viz., the tip of the outer malleolus and a point half an inch below and a little behind the inner malleolus—makes an incision with a small catlin, straight across the sole of the foot and down to the bone. Some surgeons recommend the incision to be sloped towards the heel, which diminishes the size of the plantar flap, and renders the operation easier, as there is not then so much tissue to dissect off the bone. In cases where there is much prominence of the heel, this modification may, in the writer's opinion, be adopted. Having made the incision across the sole of the foot, the flap is dissected off the inferior and lateral surfaces of the bone, great care being taken to keep as close to the bone as possible. This dissection had best be done with the knife recommended for the purpose by Professor Syme—a short, blunt-pointed, stout scalpel, with a strong, roughened handle. In using this knife there is but slight risk of making punctured wounds in the smaller vessels, the occurrence of which predisposes to sloughing of the flap. The dissection is continued backwards until the tendo Achillis is reached and divided.

A straight dorsal incision, at an angle of 45° to the sole of the foot and long axis of the leg, should then be made between the two points already indicated. If the incision be somewhat arched in front, as is done when the plantar incision has been carried farther back than Syme recommended, the danger of opening into the astragalo-scaphoid joint should be borne in mind, as such an accident may be a source of much embarrassment to an inexperienced operator. In the dorsal incision the structures in front of the ankle-joint are divided as well as the lateral ligaments, and the articulation exposed. Some surgeons prefer postponing the division of the tendo Achillis until this stage of the operation is reached, and much may be said in favour of doing so rather than at the termination of the dissection of the plantar flap, as recommended by Syme. The foot is then removed by disarticulation of the ankle-joint. The soft tissues over the malleoli are next dissected back, and these latter, together with a thin slice of the tibia, are removed, and the divided surfaces of the bones covered by the plantar flap. The bone section should be made at right angles to its axis. The anterior tibial artery in front, and the posterior tibial below the inner malleolus having been secured, the edges of the flaps should then be united with numerous points of interrupted suture, careful provision being made for drainage at each angle of the wound. For this purpose it has been proposed to make button-hole incisions in the flap, a procedure which is certainly to be deprecated.

In performing this amputation, it is undesirable to make the plantar incision from malleolus to malleolus, the evil results of such a course being to render the flap unnecessarily long and unsymmetrical, while increasing the difficulties of dissecting it off the bone, and thus imperilling its vitality. The writer has derived much aid in forming the plantar flap—the most tedious and difficult part of the operation—from the use of von Langenbeck's periosteal raspatory. An objection has been made to this plan on the ground that by leaving portions of periosteum in the flap, spicula of bone may be developed, which prove a source of trouble; but such osseous developments the writer has never satisfied himself of, and there is negative evidence to the contrary. In reference to the vitality of the flap, Erichsen does not consider the division of the posterior tibial artery an accident of serious moment, a view in which Lister and the late Professor Spence coincide.

Mackenzie's Modification, which is similar to that described by Roux, consists in making the flap from the antero-internal aspect of the joint, thereby including the posterior tibial artery, and thus diminishing, it is alleged, the risk of sloughing; but since it has been shown that a wound of that vessel is not so serious an accident as is generally supposed, this modification cannot be regarded as an improvement on the original. In fact, the flap, being one unaccustomed to pressure, is at an obvious disadvantage.

In Pirogoff's Osteo-Plastic Amputation, while the line of incision is the same as in Syme's, the essential difference is that the posterior portion of the os calcis is left in the flap, and subsequently united to the extremity of the tibia. Having made the plantar incision as in Syme's amputation, a straight one is made across the dorsum of the foot half an inch in front of the anterior tibial edge; the tendons and other structures in front, and at each side of, the ankle-joint, are divided, and the articulation opened into. The foot is then extended, and the os calcis divided obliquely downwards and forwards, with a saw following the line of the plantar incision. The soft tissues are then dissected off the malleoli, and these, with a slice of the tibia, removed. The cut surfaces of the bones are then applied closely together, and the edges of the wound united by numerous points of interrupted suture, a small drainage-tube being inserted at each angle.

The objections that have been made to Syme's amputation have been chiefly based on its difficulty and tediousness, the unnecessary shortening of the limb, combined with the risk, despite all precautions, of sloughing of the flap. Pirogoff's modification is undoubtedly a procedure of easier performance, getting rid, as it does, of the difficulty attending the dissection of the flap off the os calcis. Moreover, the stump obtained is longer than in Syme's amputation, the additional length corresponding to the amount of bone left in the flap, while the heel, long accustomed to bear the weight of the body, remains untouched. Possessing as it does these advantages, it may be asked, Why has not Pirogoff's modification superseded Syme's? The answer is that in the majority of cases of caries of the tarsus, the disease is seldom found localised, and the portion of bone left in the flap is liable to become affected, probably necessitating further operative measures, which may involve amputation of the leg. At the same time, if structures, previously healthy are dealt with, as, for example, in cases of gun-shot injury, Pirogoff's method may be selected.

Pirogoff's method has, in its turn, been the subject of much modification; for example, oblique division of the tibia upwards and backwards (Sédillot), with the view of diminishing the tension of the tendo Achillis. This has been properly objected to on the ground of its throwing the point of pressure behind the axis of the leg. Horizontal section of both os calcis and tibia (Pasquier); leaving the malleoli untouched, and placing the cut surface of the os calcis between them (Fergusson); concave section of the os calcis and convex of the tibia (Bruns), are, among others, modifications which have been made, but in which the writer fails to see any advantage. If the operator has any apprehension as to difficulties arising in keeping the cut surfaces of the bones together, tenotomy of the Achilles tendon, or suturing the bones with silver wire or chromicised catgut may be adopted. No other modification of the operation is indicated.

William Stokes.

ANKLE-JOINT, Diseases of the.—The ankle-joint, concerned as it is in transmitting the weight of the body to the foot, and also in the movements of active progression, is especially liable to sprains and concussions, and thus to the various inflammatory conditions to which such injuries give rise.

Synovitis, acute and chronic, is of frequent occurrence. The acute form is characterised by the usual symptoms, pain, heat, and swelling; the movements of the foot on the leg being restricted, and giving rise to increased pain. The swelling is manifest chiefly beneath, and at the sides of, the extensor tendons, but may also extend to the borders of the tendo Achillis.

The *treatment* will consist, in the early stage, of antiphlogistic measures, leeches, or the application of cold; subsequently, of counter-irritation, and the use of pressure by strapping and bandaging. The joint is to be kept at rest by placing the leg on a splint with a foot-piece, such as McIntyre's.

The chronic form of synovitis of the ankle may result from frequent sprains (the joint having once been sprained is liable to a recurrence of the injury because of the resulting relaxation of its ligaments), or, as is not uncommonly the case, may have its origin in an articular ostitis spreading to the joint. The scrofulous form of the disease more often affects several of the articulations of the foot; it may, however, be confined to the ankle, producing the usual pulpy swelling of the synovial tissue, and, if progressive, leading to ulceration of the cartilages and suppuration of the joint. Matter usually points at the side of the joint, and when this stage has been reached, crepitus will usually be felt on flexion and extension of the foot.

At the commencement of the disease counter-irritation by repeated small blisters, or by the actual cautery, must be used; followed by strapping over mercurial ointment, or by elastic pressure.

In most of the chronic forms of disease of the ankle, or other joints of the foot, the part may be kept at rest by means of a plaster of Paris, leather, or other splint, while the patient goes about with the aid of a peg-leg, which supports the weight of the body on the bent knee, the foot not being used.

The ankle is especially liable to a form of recurrent synovitis, due to the presence of intra-articular adhesions which have had their origin in a sprain or other injury. In such cases there is usually not much synovial effusion, though the amount varies with the use of the joint; but the patient is afraid to use the foot freely, movement in some particular direction being always restricted and painful. Attempts at greater activity being always followed by increased pain and swelling, the patient spends his time between alternations of enforced rest and painful endeavours at resuming activity. These cases are to be treated by forcible rupture of the adhesions, which usually produces an immediate cure. Anæsthesia being produced, the adhesions are ruptured by forcible flexion, after which the foot is freely moved in all directions. The patient is then to be encouraged to use the foot freely. *See* Bone-Setting.

Suppuration of the ankle-joint must be treated by free incision and drainage, and if there be pulpy degeneration of the synovial membrane, the diseased tissue must be scraped or destroyed with caustics.

Should the disease still progress, but yet remain confined to the ankle-joint, excision may be performed; but extension is very apt to occur to the neighbouring joints of the foot, in which case amputation will be needed, either by the method of Syme, or in the lower third of the leg.

J. Warrington Haward.

ANKYLOSIS.—By ankylosis is meant a joint stiff from changes in one or more parts of the articulation, in the synovial membrane and capsule, ligaments, or bones. The term implies that all active disease has ceased. Joints stiff from such causes as cicatricial contraction after burns, or diseases such as ossification of tendons, are said to be affected with spurious ankylosis, but such conditions will not be considered in the present article. Ankylosis, always the result of inflammatory action, may be, (1) soft or fibrous, (2) bony :—

(1). Ankylosis, due to changes external to the actual joint, but involving the parts immediately in relation with it, is one of the commonest forms. It is usually due to traumatic causes. The non-elastic capsule and synovial membrane being torn by the injury, probably associated also with tear of tendons at their insertions, a degree of inflammation is set up. Lymph is effused, and binds the folds of capsule together, or uniting the fibrous structures around the capsule limits mobility. Such adhesions, if neglected, develop ultimately into material more or less fibrous and tough. The inflammation may extend more widely, and the capsule and ligaments, at one time infiltrated and soft, will subsequently shrink and thus further impair mobility. Too prolonged rest, after even slight inflammation, will lead to considerable soft ankylosis, as may often be seen after dislocation of the shoulder. The changes in the cartilage in this form will be merely such as result from disuse.

(2). If the cartilages be involved, as commonly happens in pulpy degeneration of joints, granulation tissue, fibrous according to its age, will unite the opposite articulating surfaces. The disease may stop here, and the bands may even ultimately ossify, but this rarely happens. The cartilaginous tissue loses its characteristic qualities, becomes fibrillated, and degenerates more and more; even though the disease stops short here, with the changes in the parts around, firm fibrous ankylosis results. Commonly the disease extends through the cartilaginous laminæ and the calcified layer at their base, ultimately involving the bone. Now the opposed bony surfaces come into contact. The effused granulation-tissue, filling up the irregular erosions, forms into short, broad, fibrous bands, which firmly unite the opposed surfaces. In the course of time, usually to be measured by months, these bands may ossify; thus bony ankylosis is produced, necessarily associated with fibrous ankylosis around the joint. In the course of years the line separating the contiguous bones will almost disappear, and on section the cancelli will appear to pass uninteruptedly across. A still more complete bony ankylosis is seen as the result of osteo-arthritis. Here not only are the bones welded together, but the soft parts around undergo complete ossification. This condition usually affects more than one joint. It is most frequently seen in the small joints, such as those of the phalanges or tarsus.

Soft ankylosis will always permit of some amount of movement. If moving the joint, i.e. stretching the adhesions, causes pain, we may judge that the ankylosis is soft; but it may be readily mistaken for that which is bony unless examination is also made under complete anæsthesia. It is very common to mistake a joint held stiff by contracting muscles for one which is really ankylosed. No satisfactory diagnosis, where there is any considerable degree of ankylosis, can be made without the aid of anæsthetics. A greater or lesser degree of ankylosis usually follows a compound dislocation, and the closer the normal apposition of the articulating surfaces the more likely is the union to be bony, e.g. compound dislocation of the elbow or ankle is more liable to terminate in bony union than that of the knee, and spinal caries often results in complete fusion of two or more vertebræ.

Pulpy degeneration of joints, especially of the knee, is apt, after more or less destruction of the cartilages, as the process of natural recovery, to progress slowly to bony ankylosis. In the hip-joint, however, this result is far less common.

The *symptoms* of ankylosis consist of impairment or loss of mobility; pain on manipulation if the soft ankylosis is moderately recent, complete loss of movement under anæsthesia if the ankylosis is bony. The commoner form of ankylosis is the soft, arising from some injury, the most usual being dislocation. A few bands external to the actual joint glue the folds of the capsule together, but every movement causes pain, and consequently rest is persevered in too long; or, as in the case of the shoulder-joint, the movement of the scapula on the trunk is mistaken for movement of the humerus on the scapula. Degenerative changes follow as they would in a perfectly healthy joint kept absolutely at rest. The synovia ceases to be secreted, the vascularity of the membrane diminishes; the cartilage tends more and more to resemble connective tissue; the bone becomes porous, light, and thin. Still, all this can be recovered from if the adhesions be broken through. The folds will again separate, and with the restoration of mobility the structures of the joint will rapidly recover.

Treatment.—It is of the utmost importance to break down, and not merely to stretch, the adhesions; their situation can be ascertained by localising the pain felt on manipulation without an anæsthetic—that is, by stretching. Bearing in mind the anatomy of the joint and the normal movements of which it is capable, a sharp, decided movement should be made, and the adhesion will break with an audible snap—one form of ‘bone-setting.’ This treatment is especially applicable to ankylosis from traumatic causes, and to those who are pathologically young. Scarcely any inflammation follows if the adhesions be really broken through; the process, if efficiently performed, is more alarming than painful, and the after-treatment consists merely in passive and active movements to prevent the adhesions from re-forming, with shampooing and douching. In slight, soft ankylosis of the shoulder, the wrist, the knee, and phalangeal joints, the result will be successful in inverse ratio to the extent of the adhesions and the length of time that has elapsed since the inflammatory action. The latter can be estimated better by the history than by the amount of wasting of the muscles, for this is often very rapid, especially in cases of ankylosis of the shoulder in elderly people.

In ankylosis from disease, the relation of important vessels and nerve-trunks to the joint, and the possibility of their being adherent to the capsule, must be borne in mind, particularly in such as are likely to be the subjects of atheromatous changes. Especially should this be remembered in the case of the hip and knee, in both of which joints undue extension might lead to serious consequences. In the elbow it is very rare to restore perfect mobility, even after slight ankylosis. In soft ankylosis of the hip in young children, gradual extension, to be applied at the outset in the new axis of the limb, is preferable to attempts to rupture the adhesions. Violent movements are very liable to awaken the hip-joint disease in delicate subjects, and some amount of ankylosis with the limb almost in a straight position is often the best result that can be obtained. The same is true of the knee-joint, if there is backward displacement of the bones of the leg. Soft ankylosis of the knee, with the leg strongly flexed on the thigh, is a common result of neglected inflammation of the joint. Here, gradual extension cannot be so well employed. Under an anæsthetic the limb can be forcibly straightened, the adhesions being often better broken by strong flexion rather than by extension. The limb can thus be placed in a useful position, even though some degree of backward displacement results.

The results of tenotomy in the treatment of ankylosis are, as a rule, rather disappointing in cases of hip and knee ankylosis; but, as a preliminary to gradual mechanical extension, it is often beneficial. In division of the hamstrings no attempts should be made to divide more than the contracted tendons. Treatment by gradual extension, then, is applicable to those cases where the ankylosis is fibrous and the object is not so much to attempt the restoration of mobility as to place the limb in a useful position. It is especially applicable, therefore, to the hip and knee when the amount of organic change suspected forbids the employment of violent extension; but even where the adherent and contracted parts have been forcibly ruptured, no attempt should be made to place the limb at once and fix it in the position it is hoped ultimately to obtain. The forcible extension should be regarded only as a preliminary to treatment by gradual extension. The weight and pulley will be found to answer better than the more complicated and expensive apparatus.

Bony Ankylosis, when the parts are in good position, should be left alone. An exception may be made in the case of the temporo-maxillary joint, in which, however, disease is very rare. Here, by osteotomy of the ramus of the jaw, a false joint may be established with advantage, and the joint itself has been excised with a good result. Bony ankylosis of the shoulder is exceedingly rare, and admits of no treatment. Increased mobility of the scapula makes very adequate amends for the stiffness of the joint. In the elbow complete mobility may be restored by excision, but only when the patient earnestly desires it and fully appreciates the conditions; an elbow ankylosed at about a right angle impairs but little the utility of the arm. In the case of the wrist no operative interference is admissible. In the phalanges amputation may be necessary to get rid of a deformed finger or toe. In the case of the great toe excision can often be performed with advantage. Bony ankylosis of the hip may demand treatment if the deformity be great. Examination under full anæsthesia is, in this case, imperative, and care must be taken not to mistake the production of lordosis for movement at the hip. The less the destruction of the internal parts of the joint, the more favourable the case for treatment. Cases of osteo-arthritis are the most favourable of all. Subcutaneous osteotomy of the neck of the femur (q.v.), by Adams's or Sayers' method, is the best treatment. The results of the operation in suitable cases are very satisfactory. The bone may be divided also below the trochanters, but this is not so favourable an operation, though sometimes the only one that offers. Complete bony ankylosis of the knee in a faulty position may require osteotomy. The results of Macewen's operation for genu valgum show the amount of deformity that can be rectified by simple osteotomy, and it will probably not often be found necessary—as many advise—to remove a wedge-shaped piece of bone. If done, this should be so performed as to preserve the epiphysial line. Attempts to perform the operation subcutaneously in the case of the knee are not to be recommended. Bony ankylosis of the vertebral joints admits of no treatment, save, perhaps, in the case of the sacro-coccygeal joint. *See* Bone-Setting; Jaws, Closure of the; Osteotomy.

C. T. Dent.

ANOREXIA.—Loss of appetite.

ANOSMIA.—Loss of the sense of smell.

ANTERO-POSTERIOR SPINAL CURVATURE (not due to spinal caries or hip-joint disease) is an exaggeration of the normal antero-posterior curves of the spinal column. If the dorsal curve with convexity backwards is most marked, the deformity is known as *cyphosis* (kyphosis); and when the lumbar curve with convexity forwards is predominant, it is known as *lordosis* (saddle-back). Cyphosis and lordosis are generally present in the same patient, the one compensating the other in restoring the equilibrium of the body. Lateral curvature of the spine is nearly always accompanied by some amount of antero-posterior curvature. *See* Lateral Spinal Curvature. Cyphosis, embracing the whole spine from the neck to the sacrum, is not infrequently met with, where all lumbar hollow has disappeared; but lordosis is always associated with some degree of cyphosis.

The *causes* and *pathology* are the same as in lateral curvature, except that antero-posterior curvature is more often due to paralysis of the erectores spinæ muscles, as in infantile paralysis; lordosis is nearly always present in marked cases of pseudohypertrophic paralysis, when the patient is standing.

At first complete restoration to the normal figure of the spine is possible. In cyphosis, after the lapse of months or years, the bodies of the vertebræ and the intervertebral substances become misshapen, and too much wedge-shaped from before backwards, so that at last they become so fixed or ankylosed that all attempts to restore the spine to a normal, or even improved, position end in failure. It is always easier to restore or improve the position of the spine in lordosis, where there is much less tendency to deformation and ankylosis of the vertebræ.

Symptoms.—The patient generally complains of much backache and neuralgia from irritation of the spinal nerves. The thorax becomes contracted and flattened anteriorly, or is often pigeon-breasted. The scapulæ are too far apart, and their lower angles too projecting. The abdomen is too prominent, and the patient walks with a slight waddling gait. His powers of endurance are affected, and he is easily tired; his general health fails, and congestive headaches are frequent.

The *diagnosis* presents little difficulty. Lordosis cannot be mistaken for anything else. Cyphosis can only be confounded with spinal caries. When the cyphosis is of recent origin, all deformity and unnatural projection of the spine disappear when the patient lies prone on the ground; even in severer cases, where the deformity persists in the prone position, the erectores spinæ muscles feel as soft and normal opposite the chief prominence of the convexity as at any other point of the spine; whereas, in spinal caries, the same muscles opposite the seat of the greatest projection give a more unyielding sensation to the touch, and are apparently enlarged, as compared elsewhere along the spine. This softness of the erectores spinæ muscles, with little or no pain on violently concussing the heels while standing, and with the presence of some slight movement of flexion or lateral flexion even in very severe cases, will confirm the diagnosis of cyphosis from spinal caries.

Prognosis.—The tendency of antero-posterior curvature, especially of cyphosis, is to become gradually worse if left untreated, so that the patient becomes prematurely bowed down to the ground, as in old age.

Treatment.—In lordosis and in cyphosis, where the spine is still movable, the same treatment is advised as in lateral curvature, viz. medical gymnastic exercises, with attention to good postures at all times. No article of clothing is to be too tight across the front of the thorax or neck, when the patient is placed in the most improved position possible.

In lordosis, exercises effecting thorough flexion of the spine, e.g., sitting on the ground with the knees extended, and the patient touching the toes without bending the knees, or the same while he is standing, are very useful in addition.

In cyphosis, where the spine is partially ankylosed, and where there is much pain or aching in the back, relief may be obtained by the wearing of a well-applied plaster of Paris jacket, cut open in front, and made to lace; or a poro-plastic or other support with pelvic band, which will probably have to be worn for several years, till the ankylosis has become so complete as to admit of the patient going about without any support at all, free from pain or discomfort. No treatment is required in cases of ankylosed cyphosis unaccompanied by pain or aching.

Bernard Roth.

ANTHRAX. *See* Carbuncle.

ANTISEPTIC SURGERY.—By the term ‘antiseptic surgery’ is meant those modes of treating wounds in which an attempt is made to prevent fermentation in the fluids of the wound; thus applied, the term includes a variety of methods, and the use of a large number of antiseptics.

The original aim of antiseptic treatment was to prevent putrefaction, and the freedom of the discharge from foul smell was looked on as proof that the object of the treatment had been attained, and that the patient was safe from the risks usually associated with, and at that time supposed to be dependent on, a putrid state of the discharge. As experience increased, it was, however, soon found that, in spite of absence of smell from the discharge, the patient was by no means safe from many of the accidents at first supposed to be closely connected with putrefaction, such as suppuration, erysipelas, septicæmia, and pyæmia. The rapid advance of science in this department has now shown that many of these infective diseases are due to the growth of specific micro-organisms in the fluids or tissues of the patient affected; and has further taught us that none of these organisms produce putrefaction in organic fluids. It is thus evident that absence of smell is no test of the absence of these septic agents from wounds; for, on the one hand, the micro-organisms which cause putrefaction may have been excluded from the wound, or prevented from developing, while, on the other hand, the real septic agents may be present in an active state.

But investigations have taught us that the growth of micro-organisms in an organic material is accompanied by changes in that material, the nature of these changes depending on the variety of bacterium which is there developing; in fact, as the result of the growth of these minute bodies, the organic matter undergoes fermentation. These considerations have led the writer to enlarge the definition of antiseptic treatment from 'treatment directed against the causes of putrefaction' to 'treatment directed against the causes of fermentation'—in other words, against the development of micro-organisms in wounds. It is not necessary in the present article to enter into the reasons for regarding micro-organisms as the causes of fermentations, nor into the mode in which they act; that they are the causes of the fermentative changes which organic material undergoes has been thoroughly debated, and may now be regarded as settled. *See* BACTERIUM.

It must not, however, be supposed that it is only by causing fermentation in the wound that these micro-organisms are dangerous. Some, no doubt, can only grow in the discharges or dead tissues in a wound, and are unable to penetrate into and live in the body; but nevertheless these may lead to the formation of poisonous products in the wound, which, being absorbed, give rise to more or less serious symptoms, and even to death (traumatic fever, septic intoxication, and some forms of septicæmia), while their local effect may be evidenced by inflammation, suppuration, &c. Others, however, can penetrate directly into the tissues, lymphatic vessels, and blood, and, growing there, give rise to most serious affections, (spreading gangrene, erysipelas, pyæmia, &c.) It has, however, been found that means, sufficient to prevent the growth of micro-organisms and the occurrence of fermentation in wounds, are also sufficient to prevent the entrance of these parasites into the body. If, therefore, the point aimed at in the definition be successfully reached, all that is required for antiseptic treatment will be obtained.

It is of importance to note that bacteria are not normally present in the blood or tissues in the healthy living body. This has been demonstrated as regards blood, milk, urine, and various of the internal organs, by experiments which need not be referred to here. It is also found that, with very rare exceptions, the various septic diseases follow wounds—that the bacteria are, in fact, introduced into the body through a wound. In the treatment of a case after operation it is therefore most important, with the view of preventing septic diseases, to direct our special attention to the treatment of the wound, in order to prevent the entrance of the noxious organisms into the body.

There are two modes in which attempts have been made to carry out the principles described above. In the one, various precautions are taken with the view of preventing the entrance of micro-organisms into the wound; in the other, micro-organisms are admitted, and then means are taken to prevent or interfere with their growth and fermentative action.

The first principle is that introduced by Sir Joseph Lister, and his method was at first known as the antiseptic method, though the writer thinks it better to call it the aseptic method, in contradistinction to the second class of methods, which are also all more or less antiseptic. This is the method with which we have to do in the present article.

The second principle may be carried out in various ways, which will be considered separately, though, as a matter of fact, in practice the two are frequently combined.

(*a*) Various antiseptics are added to the discharge, either in the wound, by injection, &c., or after it has left the wound, with the view of rendering it an unfit soil for the development of micro-organisms—*treatment by antiseptics.*

(*b*) Means are taken to allow the discharge to flow away as rapidly as it forms, so that it has not time to undergo fermentation to any extent in the wound—*free drainage.*

(*c*) The discharge may be washed away either by water alone or by water containing antiseptics—*treatment by irrigation and immersion.*

(*d*) The wound may be freely exposed to the air, so as to allow evaporation to take place. In this way the discharge becomes too concentrated to permit the growth of bacteria in it, and at the same time the organisms being supplied with plenty of oxygen, their fermentative action is diminished—*open treatment.* In this method means are as a rule taken to permit the rapid exit of discharge, and also very frequently the wound is washed out with an antiseptic lotion, so that as a matter of practice all the four principles just alluded to are brought into play.

(*e*) If the parts are kept at perfect rest, the health of the patient good, and not too much blood between the opposed surfaces, healing may occur without inflammation or suppuration. Here trust is placed in the power of the healthy tissues to destroy bacteria. Acting on the last two principles we have *healing by scabbing*.

For the description of the methods of wound treatment mentioned under the second heading, the reader is referred to the special articles on the subject; here we have only to do with the first principle.

In the Listerian method the object is to prevent the entrance of living organisms into the wound, and with this view a large number of precautions are taken, which will be given in detail in the latter part of this article.

A wound treated aseptically, provided that micro-organisms are excluded, that the drainage is good, the stitches not too tight, and no other local cause of inflammation is present, follows what is termed an 'aseptic course.' No inflammation occurs; there is no swelling nor redness of the edges of the wound, the skin around remaining as pale and lax as when it was stitched up at the time of the operation. The wounds are thus quite painless; but not only is there absence of inflammation along the cut edges of the skin, it is also absent from the deeper parts of the wound, and there is no suppuration even where the deep structures are not absolutely in contact. The discharge from the drainage-tube is purely serous, and rapidly diminishes in amount, so as to render the drain unnecessary in a very short time. Further, the scar is linear, and very soon becomes hardly apparent, while it remains movable, and does not become adherent to the deeper structures.

While there is this absence of local disturbance in wounds treated aseptically, the constitutional state of the patient remains good; in fact, if he has not lost much blood during the operation, or if the operation has not caused shock, he is, on recovery from the effects of the anæsthetic, practically as well as before. His appetite is good, and there is no necessity for restricting his diet; at the same time traumatic fever is absent. After an operation performed aseptically, and in which there is no accidental cause of elevation of temperature, such as tension, the temperature remains normal; or if the operation is at all extensive, the following changes are observed. On the evening of the operation the temperature falls below the normal, it then rapidly rises to, or it may be a little above, 100°, reaching its highest point on the following morning or evening, and then it rapidly falls to the normal line again. In some cases, before reaching the normal, it fluctuates for a day or two between 99° and 100°, but the fluctuation is not within the range of fever temperature, but within the normal range. It is very seldom that the pulse rises in equal proportion; indeed it generally remains normal.

Interference with this typical course may be due to various causes, but it is generally occasioned by the entrance of micro-organisms. If micro-organisms have entered, there is no certainty as to the result; suppuration and traumatic fever will almost certainly occur, while any of the traumatic infective diseases—erysipelas, septicæmia, pyæmia, &c.—may appear. Of the disturbing causes not due to micro-organisms, tension in the wound from retention of discharge, or from tight stitches, is the most potent. The elevation of temperature, which follows the retention of discharges in a wound, is often very striking, and the reason of its occurrence is not very clear. At the same time the local effect is to give rise to pain and inflammation in the wound, which, if not checked by restoration of the drainage, may go on to suppuration. This disturbance is easily remedied by proper application of a drainage-tube. If, in spite of thoroughly efficient drainage, the inflammation still goes on, the cause is evidently the entrance of micro-organisms. Tight stitches also cause inflammation of the edges of the wound, which subsides as soon as the stitches are cut or removed, and movement of the parts will also interfere with the aseptic course. The irritation of the antiseptic employed may also interfere with healing, if it is allowed to come directly into contact with the wound. It is for the purpose of excluding the antiseptic from direct contact with the wound, that the layer of prepared oiled silk is applied beneath the dressing.

Carbolic Acid.—Various antiseptics are employed in aseptic surgery. The first which was introduced, and still in many respects the best, was carbolic acid. This is employed in the form of lotions, oily and spirituous solutions, and gauze dressing. The carbolic lotions are of two strengths, 2½ p.c. and 5 p.c. These are watery solutions of the pure acid, and they ought to be quite clear. If they are not clear, the reason is the presence of impurities in the carbolic acid, which are apt to be very irritating to the wound and to the skin. The 5 p.c. lotion is used for disinfection of the skin, instruments, and hands of the operator and assistants, and also for the spray. The 2½ p.c. is the lotion used for washing the sponges and for cleansing the wound afterwards.

Carbolic oil is employed of various strengths, generally 1 in 5, 1 in 10, and 1 in 20, consisting of carbolic acid mixed with olive oil in the foregoing proportions. The 1–5 oil is seldom used, though it is occasionally applied as a dressing to very foul wounds. The 1–10 oil is used as a dressing for wounds in the neighbourhood of the anus, penis, &c. Carbolic oil (1–20) is used for oiling catheters or other instruments before introducing them into the bladder. In many cases, glycerine solutions of carbolic acid are now employed in place of the oily.

A solution of carbolic acid in methylated spirit (1–5) is also sometimes employed for injection into compound fractures or wounded joints, where the injury has happened some hours before the case is seen.

Carbolised gauze is the material generally employed as a dressing to guard against the entrance of the causes of fermentation. This is ordinary fine unbleached tarlatan, impregnated in various ways with one part of crystallised carbolic acid, four parts of common resin, and four parts of paraffin. These materials, mixed together, are added to an equal weight of unprepared gauze. The gauze ought to be kept in a tin box, closing tightly, to prevent evaporation of the carbolic acid. It is used either in the form of folded dressings, loose gauze, or bandages. The dressing consists of a piece of gauze of sufficient size to overlap a considerable area of skin around the wound; this is folded in eight layers, and beneath the outer layer a piece of macintosh cloth is placed, with the rubber side downwards. This macintosh ought to be sponged with 1–20 carbolic lotion before being placed in the dressing.

The steam spray-producer is ordinarily used. In the glass vessel 1–20 carbolic lotion is placed, and this, mixed with the steam, is diluted to about 1–30.

Carbolised silk is often used for sutures, and is made by steeping silk thread in a mixture of nine parts of beeswax and one part of carbolic acid, melted together. As the thread is taken out of the mixture it is drawn through a cloth to remove the superfluous wax.

Carbolised catgut, made by immersing catgut in carbolic oil, was formerly used for ligatures and sometimes for stitches; but lately a new catgut has been employed, made with a watery solution of chromic and carbolic or sulphurous acids. This new catgut is kept dry, and an hour or two before use it is immersed in 1–20 carbolic lotion.

Sponges are washed after an operation, and are then kept soaking in a jar containing carbolic lotion 1–20. During an operation they are washed in 1–40 carbolic acid lotion.

Salicylic Acid.—Various substitutes are employed in aseptic work, one of the best being salicylic acid. This is used chiefly in the form of lotion, and wool or jute. The lotion is a saturated watery solution, and contains about 1 part of the acid in 300 parts of water. This is only used for washing wounds; carbolic acid is employed for the disinfection of the hands and instruments, for the spray and for washing the sponges.

Salicylic wool or jute are cotton wool or jute containing salicylic acid, and two different strengths are employed, the material having 3 or 10 p.c. by weight of salicylic acid. Glycerine is generally added to the solution in order to make the crystals stick better to the wool. In applying the dressing, a piece of perforated guttapercha tissue, covered by carbolic gauze, is placed next the wound; over this comes one finger's thickness of the strong wool or jute, and then two fingers' thickness of the weak wool. No macintosh is required. In some cases where inflammation is present, this dressing is kept wet with the salicylic acid lotion.

Salicylic acid is also sometimes used as a powder mixed with other substances, such as starch, zinc oxide, &c. The wound is dusted with the powder with the view of forming a crust, and healing is thus obtained by scabbing. This method is really only of use in small wounds. The objections to its use in large wounds are that the pain is great, the material expensive, and there is very apt to be confinement of the discharge.

A salicylic ointment is used for superficial wounds, and is made in the following manner:—Make a basis of two parts of paraffin to one part of vaseline. Take of this twenty-nine parts, and of powdered salicylic acid one part. Salicylic acid cream, made by mixing salicylic acid crystals with glycerine to the consistence of cream, is very useful for application around a wound where a dressing is to be left on for some days. It prevents and diminishes the eczema which sometimes occurs under these circumstances.

Acetate of alumina is apparently a very good antiseptic, and is used by Maas and others in place of carbolic acid. The lotion is a watery solution of the strength of 2½ p.c. The strength of the spray is also 2½ p.c. A piece of protective, dipped in this solution, is applied next the wound, and covered with lint soaked in the solution. Outside the lint comes a piece of macintosh, and the edges of the dressing are surrounded by salicylic wool.

Eucalyptus oil is a powerful antiseptic which is useful sometimes as a substitute for carbolic acid. It is chiefly employed in the dressing, the gauze being made with eucalyptus oil instead of with carbolic acid. It is not so poisonous nor so irritating as carbolic acid, and is therefore applied in cases where carbolic acid cannot be borne, but it is not so trustworthy as an antiseptic.

Bichloride of mercury is coming very much into fashion of late, and it may perhaps ultimately replace carbolic acid, but as yet there are several grave objections which must be overcome. Max Schede employs two solutions: a weak, watery solution of $\frac{1}{50}$th p.c. strength, and a strong watery solution of $\frac{1}{10}$th p.c. These are used for disinfecting the skin, and as lotions for the wound, &c. For the spray and the disinfection of instruments, carbolic acid is still employed. A sublimate dressing is used, made by soaking gauze or wool in the following solution: corrosive sublimate 10 parts, glycerine 500 parts, and alcohol 4,490 parts. Von Bruns employs wood wool impregnated with ½ p.c. sublimate and 5 p.c. glycerine. Sir Joseph Lister suggests a solution in serum for making the gauze, thinking that the combination with serum diminishes the irritation caused by the sublimate. As yet the best mode of employing it is only being worked out.

Napthalin, thymol, iodoform, and various other substances are also employed.

When a wound becomes quite superficial, various preparations of boracic acid may be used with advantage.

Boracic lotion is a cold, saturated solution of boracic acid in water. Boracic lint is ordinary surgical lint soaked in a hot saturated solution of boracic acid, and then hung up to dry. Boracic ointment of various strengths is also used. The full strength ointment contains, of the same basis as previously mentioned for salicylic ointment, 5 parts, and of boracic acid crystals 1 part. Boracic ointment may also be used of ½ or ¼ the above strength.

For the purpose of purifying sinuses, ulcers, &c., a solution of *chloride of zinc*—40 grs. to the ounce of water—is employed. Care must be taken in injecting this solution into a wound that free exit is allowed, otherwise it may pass into the tissues and cause gangrene.

An Aseptic Operation.—To illustrate the best method of using these antiseptics, let us consider, in detail, the precautions necessary when carbolic acid is employed. It may be convenient, in the first place, to give a list of the various things required:—

Carbolic lotions, 1–20 and 1–40.

Sponges which have been kept soaking in 1–20 carbolic lotion and are washed in the 1–40 lotion during the operation.

A large, flat dish in which instruments can be laid and covered with a layer of 1–20 carbolic lotion.

Small dish, containing 1–20 carbolic lotion, to purify the skin of the patient.

Small dish, containing 1–40 carbolic lotion, in which hands and instruments can be repurified during the operation.

Small dish, containing 1–40 carbolic lotion, in which a piece of protective oiled silk and a piece of carbolic gauze are placed to soak. It ought also to contain a large piece of thin muslin, called a guard, to throw over the wound should the spray stop.

A steam spray-producer, containing 1–20 carbolic lotion in the glass vessel.

Towels soaked in 1–20 carbolic lotion.

Catgut steeping in 1–20 carbolic lotion.

Drainage-tubes, horsehair, and silkworm gut, in 1–20 carbolic lotion.

Stitches, silver wire, carbolised silk, catgut, horsehair, &c., in 1–20 carbolic lotion.

Protective (oiled silk coated with copal varnish and a layer of dextrine), in 1-40 carbolic lotion.

Carbolic gauze kept in a tin box till required.

A gauze dressing containing macintosh cloth, made as already described.

Bandages, of gauze or calico.

Narrow elastic bandage.

Safety pins.

Before beginning the operation, blankets and clothes are covered with pieces of macintosh cloth, outside which the soaked towels are arranged so that instruments, sponges, &c., may be laid down without being contaminated. The skin, in the neighbourhood of the seat of operation, is then thoroughly washed with 1–20 carbolic acid, though this is generally done, in hospitals, an hour or two before the operation. In any case the skin ought to be thoroughly washed with the lotion immediately before commencing the operation. This purification is absolutely essential, because the skin is covered with dust containing bacteria, which also, apparently, are abundant about the hairs, and they, possibly, also pass into the follicles. These must be destroyed, or rendered incapable of development, otherwise they would spread into the wound, and render the other precautions useless. This purification of the skin is carried out by washing it well with 1–20 carbolic lotion, the antiseptic being allowed to act for some time. It is well also, having first washed the neighbourhood thoroughly, to apply, over the seat of operation, a large cloth or towel soaked in the 1–20 solution and to allow this to remain on the part an hour, or longer if possible. The part ought also to be shaved thoroughly, especially the head, where a sufficiently large area of hair should be removed to allow satisfactory overlapping of the dressing.

The purification of the hands of the operator and his assistants ought also to be thoroughly done, special attention being paid to the nails and the folds of skin about the nails. This is best done with 1–20 carbolic lotion, though, in some cases, 1–40 is sufficient, and not only the fingers, but the whole hand, should be washed.

The instruments are purified by immersion in 1–20 carbolic lotion before the operation. A tin or porcelain trough, filled with the 1–20 solution, is employed for this purpose, the instruments being placed in it some time before the operation. They are not merely dipped; they must remain in the lotion for some time, because the carbolic acid requires a little time to act on the grease or dirt on them. The teeth of toothed instruments ought also to be cleaned thoroughly, and forceps locking by catches ought to be widely opened, so as to allow the solution to come in contact with every part. The whole instrument must be immersed, for if only the point be purified, it may happen that the impure handle is inadvertently brought into contact with the wound during the course of the operation.

The spray is useful in many ways. Whether it instantly kills all the bacteria floating in the air is certainly open to question, but it constantly bedews the surface of the wound with carbolic lotion, so that if living organisms do fall in, the action is continued, while it will hinder their development if they should not be killed. It also keeps the hands and instruments constantly moist with the lotion. Fortunately there are not many bacteria floating about in air, unless the dust has been disturbed by sweeping, &c., which, of course, ought never to be done immediately before an operation or the changing of a dressing.

The arteries are ligatured with catgut. There are three different sizes, the finest being that ordinarily employed for the smaller vessels. All ligatures are cut short.

Drainage may be carried out by means of tubes, or by capillarity—best by tubes. India-rubber tubes are employed with holes cut in them at short intervals. They are inserted to the deepest part of the wound, care being taken to use a sufficient number to drain all the recesses. At the outer end they are cut flush with the surface of the skin, because, if they project, they may be compressed and rendered inefficient. To keep the tube from slipping in, two threads of carbolised silk are fastened into it at its orifice and tied in a knot. This knot, held between the dressing and the skin, retains the tube in position. It is not essential that the orifice of the tube should be at the most dependent part of the wound, because the fluid, as it forms, wells out, and, not being putrid, that which lies at the bottom of the tube does not cause irritation. In cases where the most dependent opening would be near sources of putrefaction, it is well to have the drainage-tube in another part of the wound, even though it be not so dependent. Thus, in inguinal hernia the tube would, no doubt, be in the most dependent part if its orifice were close to the pubes, but as that would be too near to sources of putrefaction, such as the vagina and penis, the orifice of the tube ought to be at the outer angle of the wound.

Absorbable tubes are also sometimes employed, made of decalcified bone. The bone is decalcified, drilled, and soaked in carbolic and chromic acids. These tubes do not require removal; they disappear, by absorption, in a few days.

Drainage by capillarity is carried out by catgut or horsehair. These drains are only applicable to wounds, they are not suitable for abscesses.

The accurate stitching of the edges of the wound is another feature in aseptic surgery. In operating aseptically, the same care need not be taken to remove as little skin as possible as is necessary in wounds treated by other methods, where swelling and inflammation of the edges are expected.

One may take away a wide sweep of skin, such as would seem to render hopeless any attempt to bring the edges of the wound into apposition, and yet if the edges can only be opposed, and if the wound remains aseptic, union by first intention may be expected along the whole line. Three kinds of stitches are employed. The first are the so-called 'button stitches.' These are flat pieces of lead with a hole in the middle. They are applied, at some distance, on each side of the edge of the wound, and connected by strong silver wire drawn tight enough to permit the edges of the wound to come easily together. Then silver wire stitches are inserted, taking a good hold of the tissue, termed 'stitches of relaxation,' and, in the intervals between these, numerous 'stitches of coaptation,' consisting of carbolised silk, horsehair, or catgut are introduced, in order to bring the cutaneous margins accurately together. If the silver stitches are found, in a few days, to be too tight, they can be cut, but there ought to be no hurry in removing the stitches unless they are positively doing harm.

The wound having been stitched, and efficient drainage secured, the dressing is now applied. In order to protect the margin of the wound from the irritation of the antiseptic, a piece of protective is interposed between the gauze and the wound. The protective is cut a little larger than the wound, but care must be taken not to put on too large a piece. There is nothing antiseptic in its substance, and it protects the discharge beneath it from the action of the carbolic acid; therefore, if at any part it projects beyond or comes close to the edge of the dressing, it allows the causes of putrefaction to spread inwards beneath it, and prevents the carbolic acid from acting on this putrefying discharge. This protective is dipped in 1–40 carbolic lotion before being applied.

Outside the protective a piece of gauze, wet in the 1–40 carbolic lotion, is placed, overlapping the protective in all directions. If the gauze is not wet, particles of living dust might be applied directly to the wound.

The protective and wet gauze constitute the 'deep dressing.' This may often be left undisturbed for several days, only the superficial dressing being changed. In this way the wound is not irritated by the application of carbolic acid to it every time the dressing is changed. This deep dressing must be treated as a wound, being itself covered with gauze soaked in the lotion. If the deep dressing is to be left on for any length of time it is well to rub some salicylic cream around the wound.

The gauze dressing should overlap the wound to a considerable extent in all directions. It is fixed on by a gauze or calico bandage. During the movements of the patient, the edge of the dressing might become separated from the skin, and air pass into the space thus formed. To prevent this, a piece of narrow elastic bandage is applied round the edge of the dressing, its general arrangement varying, of course, with the situation.

The next point is the changing of the dressing. It is only in very rare cases that it is necessary to change it the same evening. The only cases in which this is usually done are large empyemata or very large abscesses, and cases of amputation at the hip-joint, where the discharge of bloody serum is profuse, and where there is but little space for overlapping of the dressing.

As a rule, the dressing ought to be changed entirely the day after the operation, the deep part as well as the superficial. The dressing is changed under the spray, all the precautions as to disinfection of hands and instruments being taken. In removing the dressing, care must be taken that the edge next the spray is first raised, so that the spray passes into the angle between the dressing and the skin. The condition of the stitches and the drainage-tubes are attended to; a new dressing is then applied in the same way as before described. In future, the dressing is changed whenever discharge is found to have come through at the visiting hour; if there is no discharge through, and no other reason exists for changing the dressing, it is left till next day at visit, and then the same rule is followed. A dressing is never left longer than a week unchanged.

When the wound becomes quite superficial, boracic dressings may be used. The wound is washed with boracic lotion, a piece of protective dipped in the lotion is applied, and outside this one or more layers of boracic lint, overlapping the protective well in all directions. This dressing is changed every two or three days.

Boracic dressing is also very useful for ulcers. Where these are septic, the solution of chloride of zinc—40 grs. to the ounce of water—is thoroughly applied to the surface, and the skin around is washed with 1–20 carbolic lotion. In place of the chloride of zinc solution iodoform is sometimes used. In any case the boracic dressing is afterwards employed. The chloride of zinc or iodoform, as a rule, requires only to be applied once, but should putrefaction not be eradicated the application is repeated. In some cases boracic or salicylic ointments are preferable to the protective, especially where there is any cavity, or where the patient dresses the ulcer himself. Outside the ointment comes the boracic lint. Where much inflammation is present, the boracic lint may be used as water dressing, the wet boracic lint being covered with a piece of macintosh.

Treatment of Abscesses.—One of the most important points is the position of the opening. The ordinary rule is, as formerly, that the most dependent point should be selected, but there are many cases in which this rule ought not to be followed. The discharge which flows from an abscess-cavity after the first pus is evacuated is, under aseptic treatment, purely serous in character, and apparently unirritating. There is, therefore, no harm done if it is left to well out, so long as there is no hindrance to its exit. On the other hand, if an abscess be pointing, say close to the anus, and is opened where it points, micro-organisms are very likely to get in, and if this occurs, the course of the abscess may be altogether different; the cavity will suppurate, and healing be delayed, or burrowing of pus may occur, and sinuses remain open for a very long time. It is thus of much more importance to avoid putrefaction than to provide a dependent opening. A psoas abscess, for example, pointing at the upper and inner part of the thigh, ought not to be opened where it points, but above Poupart's ligament in the neighbourhood of the anterior superior spine, or, better still, in the loin. Again, retro-pharyngeal abscess is best opened by an incision at the upper and posterior border of the sterno-mastoid, a canal being burrowed in front of the vertebræ to the abscess. This has been done with complete success both by Professor Chiene, of Edinburgh, and by the writer. Again, in hip-joint abscess pointing near the perineum, an incision should be made in the healthy tissues lower down the thigh, and a canal burrowed to the abscess, The great rule, then, in opening abscesses is to make the incision as far as possible from sources of putrefaction.

When an abscess is opened, instead of dealing tenderly with the pyogenic membrane, as was formerly done, under the impression that it was a hurtful thing to injure it, we now empty the cavity thoroughly, especially in the case of chronic abscesses, in order to get out all curdy masses of pus which may have gravitated to the bottom of the abscess, and in many cases we scrape out the pyogenic membrane with a sharp spoon. When this is done, opportunity is given for the rapid adhesion of the greater part of the wall of the abscess-cavity.

The abscess is opened with the same precautions as were previously detailed as regards other wounds, the cavity is emptied, contents scraped out in the case of chronic abscesses, and free drainage provided, the points mentioned before being carefully attended to. The same sort of dressing is applied in the same way, with the exception that no protective is required, its use being to promote healing of the incision in the skin. *See* Abscess.

So much for wounds made by the surgeon; there remains for consideration the case of wounds produced accidentally. Here the problem is different from, and much more difficult, than the former. In the cases we have as yet been considering, we had merely to keep out septic particles; in the present instance, these particles have already gained admission, and therefore we have not only to prevent the entrance of more, but also to destroy those already present.

The purification of the wound is effected by washing it out with carbolic lotion, provided the accident happened within twenty-four hours of the case coming under treatment. This must be done very thoroughly. The best way is to use a syringe, with a gum-elastic catheter attached to it. The point of the catheter is introduced into all the recesses of the wound, and the 1–20 lotion is injected through it. Care is taken that the lotion can flow out freely. The skin around must also be thoroughly washed with the same lotion, and all dirt carefully removed. If necessary, the orifice of the wound is enlarged, and in any case free drainage by means of tubes is provided. The drainage and subsequent treatment is the same as in wounds made by the surgeon. If the wound was made twenty-four to forty-eight hours before being seen, a stronger solution is used, viz., the 1–5 spirituous solution. *See* Wounds.

W. Watson Cheyne.

ANTISEPTICS are substances which are directed against the causes of putrefaction. Now the putrefactive as well as other fermentative processes have been shown to be due to the growth of micro-organisms in the fermenting material. Antiseptics may combat this fermentation in two ways: either they may directly kill the micro-organisms—the cause of the fermentation, or they may by their presence in the fermentable material prevent the growth of these organisms, though they do not interfere with their vitality. In either case the fermentative change does not occur.

The value of antiseptics has been tested in various ways, but the most exact method is that used by Dr. Koch. It is now ascertained that many of these micro-organisms have two stages of existence—an adult form when the organism is rapidly growing, and a resting or spore form which provides for its future existence. It has further been shown that in the adult form these bodies are comparatively easily killed, while in the spore form they are very resisting. In order, then, to test the value of any particular antiseptic as a germicide, it is necessary to determine its relations both to the adult bacteria and to the spores. To do this, threads are impregnated with pure cultivations of these organisms in both conditions, and are rapidly dried. They are then placed in solutions of the antiseptics to be tested, washed in boiled water, and planted in a suitable soil. If they have not been killed they grow; if they do not grow the conclusion is that they have died. In the case of infective organisms the matter can be further tested by inoculating the threads into animals. The spore-bearing organisms generally used are the bacilli of anthrax; the non-spore-bearing ones are micrococcus prodigiosus. To test the value of an antiseptic to prevent the development of micro-organisms, it is mixed in certain proportions with the cultivating materials.

With regard to the antiseptics used in surgery, the following results were obtained in regard to the destruction of spore-bearing organisms.

a. A certain number destroyed the spores of bacillus anthracis within twenty-four hours. These were carbolic acid (5 per cent. in water), chlorine water freshly prepared, bromine water (2 per cent.), iodine water, permanganate of potash (5 per cent. in water), bichloride of mercury ($\frac{1}{20000}$ in water).

b. In the case of some of the solutions the spores had to be immersed for several days before they were destroyed: perchloride of iron (5 per cent. in water) for six days, chloride of lime (5 per cent. in water) for two to five days, quinine (1 per cent. in water), with hydrochloric acid, for ten days.

c. Others, again, had little or no effect on the spores, such as alcohol, glycerine, boracic acid (5 per cent. in water), benzoic acid (saturated watery solution), thymol (5 per cent. in alcohol).

The adult bacteria and non-spore-bearing bacteria are much more easily killed. Thus carbolic acid solution (5 per cent. in water) kills these in less than two minutes; indeed much weaker solutions act very rapidly: sulphurous acid, unless very strong, has little or no effect on spores, but non-spore-bearing bacteria, if moist, are killed in one to two minutes by a vapour containing ·986 volume per cent. of sulphurous acid; solutions of bichloride of mercury in water of 1 to 5,000, or stronger, probably kill instantly.

For surgical purposes it is also of great importance to know what amount of the disinfectant must be present in any given material to prevent the development of the organisms. Here, also, the bichloride of mercury is by far the most potent, for added to a gelatinised infusion of meat in the proportion of 1 to 3,000,000 no development occurred. Allyl alcohol is also very potent, a very small trace being sufficient to hinder development. Carbolic acid, boracic acid, salicylic acid, benzoic acid, and eucalyptol, prevent development in proportions varying from 1 to 700 to 1 to 1,500; quinine 1 to 625; chloral under 1 to 400; alcohol 1 to $12\frac{1}{2}$; iodine, chlorine, and bromine, 1 to 1,000 to 1 to 5,000.

In selecting these substances for the treatment of wounds, there are several points to be borne in mind, of which the following two are perhaps the most important. In the first place several of the materials mentioned before combine with albumen, and the resulting mixture or compound is generally less powerfully antiseptic than the original substance. Thus, if carbolic acid is added to such a material as Pasteur's fluid (a solution of various salts), a proportion of 1 to 600, or less, is sufficient to prevent development, while in the case of milk the writer has found that the amount of carbolic acid requires to be increased to about 1 to 50 before complete arrest of development occurs. And thus in the case of the discharge from wounds, an antiseptic, which by the above method of investigation is found not to be very powerful, may in reality answer the purpose better than one which is stronger. A striking example of this is shown in recent experiments of Schill and Fischer on the disinfection of phthisical sputum. For it was found that bichloride of mercury, which in reality is the most powerful of antiseptics when added to phthisical sputum even in strong solution, did not destroy the tubercle bacilli so rapidly as carbolic acid.

Another point to be noted is that some of these antiseptics are objectionable on account of their poisonous and irritating properties. Thus one of the chief objections to corrosive sublimate is the fact that when used sufficiently strong to be really effectual, it causes inflammation of the skin. Of course this objection may in some instances be overcome, and in fact, with regard to corrosive sublimate, Sir J. Lister finds that, when mixed with serum, it loses to a great extent its irritating properties, while it still retains a sufficient amount of antiseptic power.

The manner of using these various antiseptics in the treatment of wounds will be found under Antiseptic Surgery.

W. Watson Cheyne.

ANTRUM, Diseases of the.—*Suppuration or Empyema of the Antrum* is a form of chronic abscess, but with the peculiarity that the pus is seldom completely shut in, so as to produce distension.

In the great majority of cases, the matter constantly escapes by the anterior or posterior nares, and it is this discharge which first attracts the patient's attention.

When escaping from the anterior nares upon the handkerchief, the discharge is apt to be attributed erroneously to ozæna, but the absence of the characteristic crusts and fœtor sufficiently mark the distinction. In ozæna, the patient as a rule has lost the sense of smell, and is unconscious of his offensiveness, whereas in cases of pus in the antrum the patient is conscious of an occasional unpleasant odour, but is not disagreeable to his neighbours, though the discharge when blown on to the handkerchief may be offensive.

Often a patient suffering from pus in the antrum, complains only of a disagreeable taste in the throat and mouth on waking in the morning, particularly if he sleeps habitually on the side opposite to that of the affected antrum, the purulent fluid then slowly flowing backwards into the pharynx, and being partially swallowed, with great detriment to the digestion.

In the exceptional cases where the opening into the nose is closed, the pus tends to accumulate, and produce distension of the antrum, with absorption of the bony walls, by which the characteristic crackling is produced. It may be doubted, however, whether some at least of these cases are not instances of cyst of the wall of the antrum, the contents of which have become purulent.

In cases of distension the pain is severe, and of a neuralgic and intermittent character, but in the ordinary form there is little more than an occasional sense of uneasiness and weight about the jaws, so indistinct as often to be no guide to the side on which the mischief exists. In the great majority of cases empyema of the antrum depends upon inflammation of the lining membrane of the cavity, caused by the fangs of decayed teeth, which, if not actually perforating the membrane, are in close proximity to it, either from unusual depth of the sockets, or from absorption of the intervening thin portion of bone. It is possible, however, that the mischief may be set up by extension of catarrhal inflammation from the nose, by blows on the face, or even by the pressure of parturition in the case of an infant.

A careful examination of the teeth will, in most cases, show which of them is in fault, and though the first and second molars are those of which the fangs most frequently cause mischief in the antrum, it must be remembered that the canine frequently, and the incisors more rarely, are connected with an unusually extensive antrum.

The extraction of a decayed tooth or fang may be followed by an immediate discharge of pus, in which case an enlargement of the opening will probably be required, but frequently the tooth which set up the mischief has been long extracted, and it then becomes necessary to perforate above the alveolus. For this purpose a perforator, a gimlet, or an ordinary trochar of medium size may be employed. If the bone happens to be thin any instrument passes through readily, and the operator is aware that he has entered a cavity, and may, if he does not hold the perforator judiciously short, transfix it, and come in contact with orbital plate. But in many cases the bone is extremely dense, and the instrument is gripped so tightly that it is impossible, until it is withdrawn, to be sure that the cavity of the antrum has been reached.

Whether the perforation be made through or above the alveolus, an ordinary Eustachian catheter of silver or vulcanite will be found very convenient for washing out the antrum, and a simple india-rubber ear-syringe with a bullet-joint will be sufficiently powerful for the purpose. Ordinarily, fluid injected through the perforation flows readily from the nose, bringing away a quantity of more or less inspissated pus of an offensive character; but occasionally the cavity of the abscess does not communicate with the nose, and the fluid must then be allowed to flow back by the perforation.

The after-treatment of these cases consists in maintaining the aperture, which is often difficult, until all purulent secretion has ceased, in washing out the cavity at least twice daily with warm Condy's fluid and water, and in throwing in a small quantity of stimulating lotion such as

Zinci sulphatis, gr. ij. ad v.; Aquæ rosæ, f℥j.

When the opening is above the alveolus, there is little danger of particles of food entering the cavity; but when the perforation is through the alveolus, food will readily penetrate, unless an artificial denture be applied so as to cover the opening during mastication. If this is employed, a tube should be fitted to the perforation so as to maintain its calibre, and thus the occasional introduction of a trochar may be dispensed with. Still, it must be allowed that the cure of empyema of the antrum is often very tedious, and that many months may elapse before a patient can dispense with daily washing out of the cavity.

Since, as has been already said, distension of the antrum with facial deformity occurs only in cases in which the matter does not discharge into the nostril, it is easy to mistake an instance of the kind for a solid tumour of the upper jaw, should the amount of distension not be sufficient to produce much thinning and crackling of the bone. Again, it appears possible that the fluid portion of the matter contained in the antrum may drain away, leaving behind it a solid mass of inspissated pus and cholesterine, which, as in a case of the writer's, may by its presence induce partial absorption of the floor of the antrum with a protrusion of the palate, and all the symptoms of maxillary tumour. In order, then, to avoid an error which has overtaken very excellent surgeons, it is advisable in all cases of tumour of the upper jaw in which the nature of the swelling is not obvious, to perforate the antrum beneath the cheek, before incising the skin of the face and taking the necessary steps for removal of the jaw.

The secondary effects produced by distension of the antrum are sometimes serious. Thus protrusion of the eyeball from elevation of the floor of the orbit is not infrequent, and cases of permanent amaurosis have been recorded by Salter and Gaine, while occasionally death has been known to follow suppuration within the antrum.

Cysts of the upper jaw are by no means uncommon in which no connection with the teeth can be made out, but which certainly do not fill or in any way occupy the antrum. In fact it may be doubted whether the old term 'hydrops antri' is not altogether a misnomer, the cases which have hitherto been grouped together under that name, being either cysts of the wall of the antrum, or cysts altogether outside the antrum, pushing in its wall as they develop. The history of these cases is one of gradual, painless enlargement of some part of the upper jaw, usually close above the alveolus, the bony wall becoming so thin as to crackle like parchment, or eventually being simply membranous, in which case a characteristic bluish appearance is seen on lifting the lip, and fluctuation can be readily perceived.

In the earlier stage of the complaint, when the jaw is distended and absorption is not so far advanced as to make the nature of the case clear, a puncture with a trochar will probably evacuate cystic fluid, often containing cholesterine, and differing entirely from the mucous secretion of the lining membrane of the antrum. On incising a cyst a quantity of dark-coloured fluid of varying consistency escapes, and the finger passes into a smooth cavity not perforated by the fangs of teeth, and quite outside the antrum. By cutting away a portion of the cyst-wall so as to insure a free drainage, the cure of the cyst is gradually brought about, but very slowly. The same form of cyst is found, but less frequently, in the lower jaw.

Adams, Giraldés, and Luschka have shown that both single and multiple cysts develop occasionally from the wall of the antrum, and project into the cavity, and that polypoid growths form in the same situation. A case recently recorded by Sir James Paget supplies a symptom of such polypoid growths hitherto unnoticed, viz., the constant flow from the nostril of the affected side of clear watery fluid in considerable quantity. The patient, a lady aged 49, suffered for nearly two years from this inconvenience, and was then relieved, and ultimately cured, by the use of sulphate of zinc, locally and internally, as recommended by Brodie in a similar case. The patient dying from causes unconnected with the antrum, its 'floor was found to be covered with two broad-band convex polypoid growths, deep clear yellow with the fluid infiltrated in their tissue. They looked like very thin walled cysts, but were formed of very fine membranous or filamentous tissue infiltrated with serum.'

Epithelioma.—The tubular form of epithelioma may originate in the antrum, or, commencing in the nose, may secondarily invade the antrum. The growth is characterised by great rapidity of development and softness, and the surrounding structures are apt to be rapidly involved. Hence tumours of this class were formerly considered as examples of soft cancer. When beginning on the nasal mucous membrane, the stoppage of the nostril is generally the first symptom noticed, and possibly temporary relief may be obtained by the removal of so-called polypi. When the disease begins in the antrum it leads to a rapid expansion of the cheek, with stretching and thinning of the skin, which eventually becomes involved and ulcerates, giving exit to a fœtid watery discharge and the protrusion of a yellow fungous growth. The nose and the orbit become secondarily involved, and the growth is apt to find its way into the several fossæ of the outside of the skull.

In the treatment of this form of disease early and free removal of the upper jaw offers the only chance of permanent cure.

Christopher Heath.

ANUS. *See* Atresia Ani; Fissure of the Anus: Pruritus Ani.

AORTA, Abdominal. *See* Abdominal Aneurism.

AORTIC ANEURISM has of late years been submitted to surgical treatment with an encouraging amount of success. As regards the pathology, diagnosis, and general treatment of aneurism of the arch of the aorta reference must be made to medical treatises, and the writer will confine himself to the indications for surgical interference of various kinds.

A sacculated aneurism of the arch of the aorta is to be diagnosed in the early stages by its pressure effects, viz., pain, venous congestion and dyspnœa. The position of the sac will materially influence each of these; thus a sac pressing against the sternum is more painful than one pressing back against the trachea, whilst the latter will give rise to urgent dyspnœa in a very early stage. Increased dulness on percussion is a very important sign, and when this is combined with a strong impulse synchronous with the impulse of the heart, but not necessarily accompanied by a *bruit*, the diagnosis of aortic aneurism is confirmed.

The tendency of an aortic aneurism to appear externally is regulated very much by the site of the sac. If on the ascending portion of the arch, the sac presses against the sternum, producing gradual absorption of the front wall of the chest, and communicating a marked impulse to the right side of the sternum as high as the sterno-clavicular joint, which may be invaded by the tumour in the later stages. If on the transverse portion of the arch the sac encounters but little resistance in an upward direction, and hence is apt to invade the interclavicular notch, to compress the trachea and occasionally the œsophagus, and to produce marked spasm of the larynx by interference with the left recurrent laryngeal nerve. When a sac of this kind rises into the neck it is a matter of uncertainty to which side it should be allotted, since a tumour projecting most to the right by no means necessarily *originates* on the right side, and *vice versâ.* Some assistance in diagnosing this point may be derived from the radial pulses, which should be carefully examined both with the finger and sphygmograph. A diminution of the right radial pulse would generally indicate an aneurism of the root of the innominate; but the fact must be borne in mind that occasionally the right subclavian comes off from the lower part of the arch and may be compressed by an aneurism of the arch or by some other tumour. It becomes necessary, therefore, to compare the two carotids and to investigate the blood-supply of both sides of the head. The condition of the pupil on the affected side should also be noted, since it is not infrequently contracted from interference with the sympathetic trunk, though in certain other cases dilatation has been noted.

Given a case of aneurism of the arch of the aorta, in which the symptoms are steadily increasing in severity, notwithstanding the employment of rest, regulated diet, and various drugs, the question of surgical interference may be fairly entertained under the heads of *a*, distal ligature; *b*, galvano-puncture; *c*, introduction of certain foreign substances:—

a. The distal ligature may be applied to either carotid and either subclavian; or to the two vessels of the right side, either simultaneously or consecutively. Dr. Cockle was the first to direct attention to the remarkable curative effects produced (under a mistaken diagnosis) upon aneurisms of the arch, by ligature of the left carotid in the hands of Rigen and Tillanus, and at his suggestion the writer tied the left carotid in a case of unquestioned aortic aneurism in 1872. The patient, a farm-labourer of forty-eight, had well-marked symptoms of aortic aneurism, which was thought to involve the transverse portion of the arch.

The relief afforded by the ligature of the left carotid was marked. Within forty-eight hours the patient was able to lie on his right side, which he had previously been unable to do. The prominence of the right side of the sternum and right sterno-clavicular articulation gradually subsided, and the pulsation in the episternal notch disappeared. A year after the operation the patient was well and quite comfortable, and a few months later resumed his laborious occupation, with the result that the aneurism began again to increase and eventually burst in the middle line externally, four and a half years after the operation. The aneurism proved to be one of the ascending portion of the arch. The operation has been repeated by Holmes, Barwell, Pirogoff, Küster, and the writer, whose second case proved rapidly fatal from cerebral anæmia, the right carotid proving to have been previously occluded. Still the relief given in at least seven cases is very encouraging, and since, with improved methods of tying large vessels (*see* LIGATURES), the risk of tying the common carotid is considerably reduced, it may be hoped that the operation will be more extensively employed than heretofore.

The double distal ligature has been frequently applied on the right side, and once at least (Barwell) on the left side. In the majority of instances the double ligature has been performed for supposed innominate aneurism more or less involving the aorta, but in several examples the disease has proved to be purely aortic, as in the writer's case which occurred in 1865, the patient surviving four and a half years. Mr. Barwell, in 1879, first applied the double distal ligature on the right side for aneurism diagnosed as aortic, the patient living fifteen months in fair health and comfort, and he was followed by Dr. Lediard, whose patient lived ten months, and by Dr. Wyeth, whose patient lived one year.

Mr. Barwell (*International Encyclopædia of Surgery*) has endeavoured to distinguish the two classes of cases suitable for the distal ligature as follows :—

'*For Deligation of Left Carotid.*—Tumour symptoms upon and somewhat, but not far, to the left of middle line, and rising into episternal notch, or beneath left sterno-mastoid. Left venous congestion, alteration of left carotid, and to a much less degree, of left radial pulse. Paralysis of left vocal cord; obstruction to entrance of air, equal on both sides of chest; sometimes alteration of left pupil.

'*For Deligation of Right Carotid and Subclavian.*—Tumour symptoms on right of median line; marked changes in right radial and carotid pulses; venous congestion on right side, affecting first and chiefly head and neck. Afterwards, with increase of tumour, right arm and chest and right vocal cord may be paralysed; or, tumour symptoms on right of and upon mesial line, running up to sterno-clavicular joint and episternal notch; venous congestion on left side; alteration of right pulse, tracheal dyspnœa.'

It appears to the writer, however, impossible to lay down any hard-and-fast diagnostic lines, since each case must be taken on its merits; but he would remark that in both his cases of distal ligature which survived the operations over four years and a half each, the aneurism was on the ascending portion of the arch, and that both patients were equally benefited, the one by the double ligature on the right side, the other by a single ligature on the left. The balance of safety lies therefore clearly, *cæteris paribus*, in favour of a single ligature on the *left* side.

b. The production of clot within an aortic aneurism by the employment of electrolysis will be discussed under that heading.

c. The introduction of foreign bodies into an aneurismal sac, with the view of entangling fibrine and thus bringing about a cure, is a very desperate remedy. The first case in which the late Mr. C. Moore introduced many yards of fine iron wire, died of acute pericarditis and general inflammatory symptoms due to the foreign body. No better results have followed the substitution of horsehair. Probably the safest foreign body will be found in fine darning-needles introduced in pairs and crossing one another within the sac, so as to entangle the blood and lead to coagulation. The small experience of Mr. Marshall and the writer has been favourable as regards the innocuousness of the method, but not as respects the permanent effects of the treatment. Further experience is wanted as to the time during which the needles may be safely retained—probably at least forty-eight hours. Mr. Puzey's very interesting case will be found in the article ACUPUNCTURE.

CHRISTOPHER HEATH.

AORTIC TOURNIQUET.—A large horse-shoe tourniquet contrived by Lister for compressing the abdominal aorta immediately to the left of the umbilicus in amputating at the hip-joint. *See* DAVY'S LEVER.

APHONIA, i.e. loss of voice—hoarseness or dysphonia, if the voice is only impaired—is caused by conditions in which (*a*) the expiratory current of air is too weak to throw the approximated and tense vocal cords into vibration; (*b*) the approximation of the vocal cords is impeded; (*c*) their tension is either rendered impossible or is excessive; (*d*) the cords themselves are pathologically changed; (*e*) their vibration is rendered impossible.

Such conditions are met with—

(*a*) 1. In cases of emphysema and of extreme general weakness. 2. In cases of complete, or nearly complete, obstruction of the lower air-passages by internal tumours, foreign bodies, sub-glottic webs, external compression. 3. After tracheotomy or wounds of the trachea.

(*b*) 1. In cases of nervous paralysis, as (*α*) in bilateral or unilateral paralysis of the recurrent laryngeal nerves; (*β*) in functional paralysis of the adductors of the vocal cords; (*γ*) in paralysis of the inter-arytænoid muscle; (*δ*) in paralysis of individual adductor muscles in consequence of local disease. 2. In cases of serous infiltration of the phonatory laryngeal muscles arising in catarrhal and inflammatory affections of the larynx. 3. In cases of mechanical fixation of one or both vocal cords in positions other than that of phonation. This may be due (*α*) to cicatrices binding the cord, or cords, to the sides of the larynx; (*β*) to disease of the crico-arytænoid joints, followed by ankylosis; (*γ*) in cases in which anything intervenes between the cords, when they attempt to join. This may happen (*α*) in cases of swelling of the interarytænoid fold; (*β*) in cases of foreign bodies in the larynx; (*γ*) in cases of benign or malignant neoplasms situated within the glottis.

(*c*) 1. In cases of paralysis of (*α*) the crico-thyroid muscles; (*β*) the interior thyro-arytænoid muscles. 2. In cases of ankylosis of both crico-arytænoid joints, in which, though they are fixed in the position of phonation, they are simultaneously bound internally and forwards, so that the cords, though approximated, remain quite lax. 3. On the other hand, a peculiar form of aphonia is produced in spasm of the tensors and adductors (speaker's cramp, aphonia spastica).

(*d*) In many cases of inflammatory or ulcerative disease of the larynx, as in: (*α*) acute laryngitis, (*β*) chronic laryngitis, (*γ*) œdema of the larynx, (*δ*) benign neoplasms, (*ε*) carcinoma and sarcoma, (*ζ*) syphilis, (*η*) tuberculosis, (*θ*) perichondritis, (*ι*) lupus, (*κ*) lepra of the larynx, (*λ*) direct injury of the vocal cords.

(*e*) 1. In cases of swelling of the ventricular bands and chronic laryngitis, the swollen parts resting on, and preventing the vibrations of, the vocal cords. 2. In cases of benign neoplasms resting on the vocal cords, and acting similarly.

It is obvious that in many cases there will be a coexistence of several of the conditions just enumerated.

If the class of cases mentioned in (*a*), in which the cause of the aphonia or dysphonia will either be obvious, or become patent from physical examination of the chest, be excluded from consideration, varied, and pathologically different, laryngeal conditions remain, in which this symptom is present. It is true, that in some of these conditions, as in bilateral paralysis of the recurrent laryngeal nerves (see *Paralysis* and *Spasm* under Larynx, Neuroses of the), hysterical aphonia, and in spastic aphonia, the vocal disorder manifests itself in a very characteristic form, but even in these cases errors are not excluded, if one trusts only to the patient's history, and to the recollection of apparently similar cases. Thus the writer has known enormous laryngeal papillomata to have been mistaken for hysterical aphonia, speaker's cramp for pharyngitis, &c. In all other cases of aphonia or hoarseness, the diagnosis of the nature, and, still more, of the special form and the extent of the morbid influence, without the aid of the laryngoscope, is purely guesswork; and the most experienced observer will occasionally be liable to serious mistakes, if he trusts to the history of the case, to the general symptoms, and to his auditory faculties alone.

A certain diagnosis of the nature, form, and extent of the cause of aphonia can only be arrived at by combining laryngoscopic examination with the methods just mentioned. In this manner, and on reference to the above list of conditions giving rise to aphonia or dysphonia, the special cause of aphonia in a given case will be elucidated. The peculiarities of all these conditions are fully discussed under Laryngitis; Larynx, Neuroses of the, and Growths in the.

Felix Semon.

APHTHÆ. *See* Tongue, Diseases of the.

AREOLA. *See* Nipple and Areola, Diseases of the.

ARM, Amputation of the.—The conditions which, as a rule, necessitate amputation of the arm are compound and extensively comminuted fractures, such as are produced by gunshot injuries, gangrene, strumous disease of the elbow-joint of an extent to contra-indicate resection, necrosis, burns of exceptional severity, contused and lacerated wounds, malignant tumours of the hand or forearm, &c.

The following are the methods practised for this operation, which may be performed at any point below the attachments of the axillary muscles:—

1. The circular method.
2. Syme's modification of the circular.
3. Alanson's method.
4. Oval method (Guthrie).
5. Square-shaped flap method (Sabatier).
6. Antero-posterior flap method (Vermale).
7. Lateral flap method (Velpeau).
8. Musculo-cutaneous flap method (Langenbeck).
9. Long anterior oval flap.
10. Rectangular flap method (Teale).

Of these methods the circular is, in the majority of cases, to be preferred; but the surgeon must use his own discretion in the choice, his selection being guided by a careful consideration of the particular circumstances attending each case.

Speaking generally, he must, in cases especially of serious traumatism requiring amputation, utilise for flaps the integumentary and muscular tissues that are least involved in the injury. For such cases, therefore, no definite rules as regards length, breadth, or shape of the flaps, can be stated. In cases of disease, however, it is different. Here the structures, where the operation is performed, being healthy, the surgeon can select the procedure which, in his opinion, is attended with least risk, and is best adapted for an artificial arm, or other mechanical appliance.

In performing the foregoing amputations, provision must be made to prevent hæmorrhage by one of the following methods:—(1) Esmarch's bandage; (2) Petit's tourniquet on upper part of the arm; (3) Signoroni's tourniquet; (4) digital pressure on brachial artery; (5) digital pressure on axillary artery; (6) pressure on subclavian against first rib.

In the circular amputation, supposing the right arm is the one to be operated on, the surgeon grasps with his left hand and retracts the soft tissues, and with a straight, or somewhat curved, blunt-pointed amputation knife, divides the integument and superficial structures, with a single circular sweep round the limb, severing all the tissues down to the muscles. A flap, consisting mainly of integument and fat, should be dissected back with a full-sized scalpel for a distance of at least an inch and a half, care being taken to include all the subcutaneous tissues with the view of preserving the vitality of the flap. Having dissected and retracted this flap, the amputation knife is then applied to the muscles, and all of them divided at once down to the bone; or the superficial ones may only, in the first instance, be divided, and subsequently the deeper ones, with the vessels and nerves. Owing to the non-attachment of the biceps to the humerus, and the greater tendency it has in consequence to retract, it has been recommended to divide it at a somewhat lower point than the other muscles. The plan of dividing the superficial muscles, and subsequently the deeper ones, is, in the writer's opinion, to be preferred. The muscles having been divided, and the periosteum reached, it should be carefully incised at the point where the saw is to be applied, and the bone then sawn steadily and slowly across. Should the edges of it be sharp, they should be rounded off, either with the saw or bone-forceps, any spicula of bone being removed. The brachial, the superior and inferior profunda arteries, together with muscular branches, will probably require ligature, and should be seized with an artery forceps or tenaculum, and secured with strong carbolised catgut suture, and both ends cut short. If the plan of inserting deep, as well as superficial, sutures, as recommended by Esmarch, be not adopted, provision should be made for efficient drainage, and the edges of the flaps brought together with numerous points of carbolised or chromicised catgut sutures of medium thickness, antiseptic dressings being then applied.

As regards the other methods of amputation, the writer is of opinion that the merits of Syme's modified circular method are not so apparent in amputations of the arm as in those of the leg, thigh, and forearm. The circular operation just described, in which the muscles are divided in layers, includes the advantages claimed for Alanson's operation, in which the muscles are divided obliquely, in both instances the wound being more or less cone-shaped. In the 'oval' method, the writer fails to see any special merit, and none whatever in the 'square flap' method of Sabatier. The antero-posterior and lateral flap operations, and the musculo-cutaneous flap amputation (Langenbeck), possess advantages which, in the opinion of many surgeons, make their adoption desirable, from the rapidity with which they can be done, and the shapely stumps that result. The rectangular method of Teale, applied to the arm, has many advocates; but, in the writer's opinion, its merits—and they are many—are more apparent in amputations of the thigh than in any others; and in connection with that group of operations, therefore, the method will be more fitly discussed.

In performing the antero-posterior flap method, made by transfixion, care should be taken in making the anterior flap to get the knife in front of the brachial vessels, which can best be done by lifting the anterior muscles well up before transfixing them. The posterior flap should be made somewhat longer than the anterior, which latter should be from two to three inches in length. The flaps then being retracted, any muscular fibres attached to the bone should, with the periosteum, be divided carefully, and the bone then sawn across. The remaining steps of the operation are similar to what has already been described in connection with the 'circular' amputation.

These methods will probably meet the requirements of the surgeon in the majority of cases. William Stokes.

ARM and FOREARM, Diagnosis of Injuries and Diseases of the.—Loss of power, pain, swelling, probably distortion, mobility in the continuity of one of the bones, with crepitus on manipulation, following immediately upon injury, are the signs of *fracture*. The humerus is occasionally the seat of *spontaneous fracture*, which in old subjects may be the result of malignant disease of the bone.

Loss of extension power following a fall on the elbow or other direct injury, with pain and swelling behind the joint, where a hard movable mass can be felt, indicates *fracture of the olecranon* with separation; if the fibrous structures around the bone are not torn across, no separation occurs, and the power of extension is not lost. *A movable bony mass* at the inner side of the elbow, after a direct blow on the part, is probably the internal condyle, which has been chipped off; a similar movable mass in other situations may be the result of a fractured exostosis.

Bony distortion about the elbow immediately consequent on injury must be due to *fracture* or *dislocation*, perhaps both. Deformity with crepitus means fracture—possibly dislocation also; without crepitus it means almost certainly dislocation—very rarely *impacted fracture*. The two conditions which may resemble dislocation are, transverse fracture just above the condyles and, in young subjects only, *separation of the epiphysis* at the lower end of the humerus. In the normal state the tip of the olecranon in extension is exactly on the level of the line of the condyles—never above it; in semiflexion it lies vertically below that line—never in front or behind. In fracture or separation of the epiphysis the whole elbow-joint may be displaced, but the relation of the olecranon to both the condyles remains unaltered; any change, therefore, in these relations indicates *dislocation of the ulna* from the humerus. Displacement due to fracture is reproduced immediately after reduction by muscular action; a dislocation, on the other hand, has not this tendency to recur. In *dislocation of the radius* only the relation of the olecranon to the condyles is unchanged, and the absence of the radial head from its usual situation below the external condyle is easily detected.

An abrupt angular bend is often found in young children, at about the middle of one of the bones, and may arise from rickety deformity, greenstick fracture, or, very rarely, intra-uterine fracture. In adults permanent angular deformity is usually due to vicious union after fracture.

Permanent *shortening of the limb*, independent of loss of bony tissue from compound fracture or operation, may be the result of congenital defect, arrest of growth after fracture in infancy, injury or disease of one of the epiphyses of a growing bone, or infantile paralysis. *Lengthening* occurs very rarely in chronic ostitis and in certain cases of osteitis deformans.

Wasting of one or more of the muscles may be due to:—(1) prolonged disuse; (2) injury to the nerves; (3) inflammation in or around a muscle; (4) acute or subacute joint-disease; atrophy of the muscles about the elbow should therefore induce careful investigation of the articulation. In children infantile paralysis is a common cause of wasting of muscles, especially the deltoid. *Hypertrophy* of some of the muscles may be the result of excessive use, and is also present in rare cases of pseudo-hypertrophic paralysis.

Rigidity of the biceps, causing 'bent elbow,' may be produced by:—(1) old inflammation about the muscle; (2) passive contraction from long use of a sling; (3) reflex contraction from disease of the elbow, or from a wound of a cutaneous branch of the musculo-cutaneous nerve.

Stiff elbow may arise from:—(1) prolonged disuse; (2) adhesions in or around the joint from old disease; (3) bony ankylosis after disease, fracture, or excision; (4) contraction of scars, probably of burns; (5) reflex rigidity of muscles; (6) deformity from fracture; (7) unreduced dislocation; (8) deformity in osteo-arthritis; (9) bony thickening after periostitis.

Loss of power of rotation in the forearm, either by voluntary or passive movement, which is persistent and complete, is found in complete ankylosis of the elbow, in vicious union after fracture of the radius and ulna, and in obliteration of the interosseous space by callus or periosteal bone.

The distressing pain and weakness known as '*tennis-elbow*,' often seen about the upper part of the forearm and elbow in players of lawn-tennis, particularly during the action of pronation, is the result of sprain of the pronator radii teres and internal inter-muscular septum. Similar symptoms, '*sculler's sprain*,' are sometimes met with amongst boating men who 'feather' their oars. An elongated tense swelling over the course of any of the tendons above the wrist, which when moved produce a peculiar creaking in the tumour, coming on, as a rule, after a sprain, or violent twisting movements, indicates *teno-synovitis.*

Sudden loss of power and sensation from interruption of nerve-supply may be caused by:—(1) injury to a nerve by direct wound; (2) complete or incomplete division of a nerve, probably the musculo-spiral, by the fragments of a fractured bone; (3) a violent blow on a nerve as it lies close upon one of the bones. In children, especially about the time of 'teething,' sudden loss of power without loss of sensation is due to infantile paralysis. *Gradual paralysis* following upon fracture is probably caused by implication of the nerve in callus; independently of fracture, it is usually crutch-paralysis or lead palsy.

Sudden, acute pain in the arm during violent attempts at flexion, immediate loss of power, swelling, and extravasation, with a rounded tumour in the mid-bicipital region and a depression above the elbow instead of the normal fulness, indicate *rupture of the biceps.* Rapid *subcutaneous extravasation* and discoloration, ensuing directly upon a strain or blow, point to a ruptured vein.

A pulsating swelling appearing rapidly or slowly after a similar injury means *rupture of an artery*, probably the brachial, and the formation of a traumatic aneurism. A pulsating tumour does not always follow rupture of the artery, in which case the history of the injury and the absence of the pulse below the rupture will point to the diagnosis. Punctured wounds over either of the large vessels may involve the artery, and should be carefully watched, as an immediate *traumatic* or *consecutive aneurism* may result.

A rounded, well-defined tumour in the course of either of the large arteries, pulsating in all directions, is probably an *aneurism*; a distinct blowing or rasping bruit is heard on auscultation, the pulse in the artery below is diminished; pressure on the vessel above arrests the pulsation in the tumour and causes a decrease in its bulk. A pulsating, rapidly-growing mass, possibly of large size, involving one of the bones, probably the humerus, with a soft purring bruit and no alteration in the pulse below, points to *osteoid cancer.*

Fulness and tortuosity of the veins over the bend of the elbow, with pulsation and a soft bruit, are the symptoms of *aneurismal varix*: if, in addition, a distinct pulsating tumour exist, the case is one of *varicose aneurism.*

Stiffness, pain, and tenderness about the elbow, with gradual distension of the synovial membrane, which bulges on each side of the olecranon without obscuring the bony points, are the symptoms of *synovitis*, which may be traumatic, rheumatic, gonorrhœal, or syphilitic. Immediate distension of the joint after injury is caused by effusion of blood. In children, synovitis is usually the effect of injury or 'struma,' or both; if the swelling slowly becomes uniform over the whole elbow, the bony eminences being obscured, *pulpy or 'fungous' disease* of the joint has set in.

The sudden appearance of fluid in the elbow-joint, in patients affected with open sores or suppurating cavities, points to *secondary pyæmic abscess.* Chronic effusion into the elbow-joint, with rough creaking and, in the later stage, bony crepitus and deformity, without very acute pain, as a rule is common in patients past middle age, as the result of chronic *osteo-arthritis.* A similar but quite painless condition, *Charcot's disease*, is found sometimes in those affected with locomotor ataxy. *Bony crepitus* in the elbow may be the consequence of fracture, acute or chronic disorganisation, osteo-arthritis, or Charcot's disease.

Vivid streaks running up the limb, with stiffness, swelling, and tenderness of the lymphatic glands in the axilla or above the elbow, indicate *lymphangitis*. Bright redness, rather diffused excepting at its upper limit, disappearing momentarily on pressure, with a tendency to spread in all directions, slight œdema and stabbing pain, are the signs of *erysipelas*. In young subjects, especially anæmic girls, about the time of puberty, bright red, raised, and circumscribed patches, which appear rapidly and subside in a few days, leaving marks like a fading bruise, are typical of *erythema nodosum*.

General chronic *œdema of the limb* may exist as a sequel to erysipelas or cellulitis, may be caused by obstruction of the venous circulation from thrombosis, or pressure on the veins by tumours or enlarged glands, and may arise from constriction high up accidentally, or in cases of neuro-mimesis and malingering.

Intense pain, tenderness and swelling over either of the bones, without redness in the earlier stages, occurring after exposure or slight injury in young subjects, are almost certain evidence of *acute periostitis*. Dull aching pain, increased at night with some thickening, often ill-defined, and tenderness about one of the bones, occurring most frequently in adults, points to *chronic periostitis*, or *ostitis*. A well-marked circumscribed swelling on the bone, with symptoms of chronic or subacute periostitis, is a *node*, which in adults is, as a rule, syphilitic, in children strumous. A painful, tender swelling around the line of one of the epiphyses, usually that at the lower end of the humerus, not involving the neighbouring joint, excepting in neglected cases, occurring in children who are the subjects of congenital syphilis, is not infrequently seen as a consequence of *syphilitic epiphysitis*, and must be carefully distinguished from pulpy disease of the joint.

An oval, fluctuating swelling, not as a rule painful or tender, over the olecranon, is the result of chronic effusion into the olecranon bursa, '*miner's elbow*,' and is prone to become acutely inflamed after slight injury. A rounded, fluctuating swelling over the lower end of the bicipital groove, slightly movable and not very tender, should lead to a careful examination of the shoulder-joint, as such a tumour is sometimes formed by *synovial extension* in chronic or subacute disease of that articulation. *See* SHOULDER.

A rather hard, fairly-defined mass, situated in the substance of one of the muscles, usually the triceps, often of considerable size, remaining for a long period without change, is probably a *gumma*. Ragged sores, with bases of slough resembling wash-leather, the result of broken-down gummata, are common about the region of the internal condyle of the humerus.

Any rapidly-increasing growth, hard or soft, painless or painful, covered with large veins, which involves all the structures around, infiltrating the skin so that it becomes adherent, is due to *malignant disease*.

A hard, fixed, circumscribed, slowly-growing tumour, springing from either of the bones near one of its extremities, causing little inconvenience excepting that produced by its weight and size, is probably an *enchondroma*. A mass of bony hardness, usually pedunculated, and not very large, springing from either of the bones, absolutely fixed, neither tender nor painful, unless a nerve or muscle is stretched over it, and growing extremely slowly or not at all, is nearly certain to be an *exostosis*. Bony tumours not being exostoses are due to the existence of (1) a supra-condyloid process; (2) ossified nodes; (3) ossified callus about an old fracture. *See* HAND, Surgery of the.

WILLIAM H. BENNETT.

ARNOLD'S LEG-SPLINT consists of a piece of tinned sheet-iron, bent slightly opposite the knee, and turned up at right angles at the lower end, to form a footpiece. The splint should be broader than the leg, so that the latter is not compressed too much by the side splints, which are straight pieces of wood reaching from just above the knee to the footpiece. A strap and buckle should be attached to the lower end of each, by means of which they may be fastened together round the footpiece. The splint is slung to a wooden cradle by straps fixed to two pairs of cross-bars, one just below the knee, and the other just above the ankle.

BILTON POLLARD.

ARTERIES, Diseases of.—The diseases of the arterial system may be arranged in the following order:—I. Inflammation and ulceration. II. Degeneration. (*a*) fatty, (*b*) calcareous, (*c*) amyloid. III. Atrophy. IV. Hypertrophy. V. Nervo-muscular disturbance—Raynaud's disease. VI. Embolism. VII. Thrombosis. VIII. Tumours.

I. ARTERITIS.—Inflamed arteries vary greatly in appearance, the diversity depending on essential or accidental circumstances. Thus the process may be acute or chronic; it may affect by preference larger or smaller vessels, and incidentally one or other of their coats; whilst it may constitute the sole morbid change, or be associated with retrograde metamorphosis, coincidental or consecutive. Hence it is customary to enumerate several kinds of arteritis. At the same time it should be borne in mind that apparently distinct pathological lesions may in reality be only successive stages of a protracted disorder of nutrition.

(A) *Acute Arteritis.*—It is now generally conceded that there is no such disease as *acute general arteritis*. The description formerly given of this supposed erysipelatous condition was founded on error; the staining of the intima with hæmoglobin discharged from the corpuscles being mistaken for inflammatory redness, and decolorised disintegrated blood-clot for purulent effusion. Moreover, at that period arteritis was believed to be a necessary antecedent to thrombosis, and primary diffuse arterial thrombosis, though rare, is known to occur, e.g. in the course of malignant blood-poisoning.

Acute local arteritis is a necessary consequence of severe injury to a vessel; thus it follows partial rupture from accident, and is the means by which an artery is permanently occluded after the application of a ligature. In these instances it is clearly conservative. Acute destructive local arteritis arises by extension of unhealthy inflammation from surrounding tissues. It is most common where the products of exudation are pent up under high pressure, or are allowed to decompose in an open wound. The end of an artery in an amputation stump may be attacked, and then the danger of secondary hæmorrhage becomes imminent. Again, a deeply-seated abscess in the neck or groin may eat its way into a large vessel, and cause serious, nay, even fatal, bleeding. The vasa vasorum of the outer coat dilate, and leucocytes infiltrate its substance. The fibrous tissue softens, swells up, and finally liquefies. Meanwhile the inner coat is involved; fibrin is deposited in the interlaminar spaces and on the free surface; and the endothelial lining is shed. Arteries below the size of the radial do not often rupture, for thrombosis precedes the destruction of the intima; but in larger vessels the blood-stream is strong enough to prevent coagulation in the continuity or to plough up a disintegrating clot in the ligatured end. The splenic, or other artery adjacent to the stomach, may be opened by an ulcer spreading from that organ.

In infective or ulcerative endocarditis, the inner coat of the aorta is sometimes eroded, partly from the friction of a retroverted calcified valve, partly from extension of the inflammation. In the same disease vegetations are not infrequently detached from the valves, and being arrested in the peripheral arteries, they excite acute inflammatory softening, with aneurism or, more rarely, rupture, as a sequel. This is known as *embolic arteritis*. Simple non-infective embolism causes only thrombosis and obliterative endarteritis.

Acute Endarteritis.—This affection selects chiefly the aorta and large trunk arteries. Syphilis has been observed in connection with it, but whether as a cause or coincidence is uncertain. On laying open the artery, small roundish, soft elevations are seen, most of which vary in surface area from the size of a small pea to three or four times that magnitude. They are semi-translucent. In tint they are greyish-pink, or faintly yellow from incipient fatty degeneration; but even then they offer a striking contrast to the dead-white and buff-coloured patches of atheroma. The appearance, which is strongly suggestive of an eruptive disease, is as if gelatine had been sprinkled over the inner coat. Calcification rarely occurs. In the earlier stages the middle and outer coats present nothing abnormal, but later on they are somewhat swollen, especially the outer, for the vasa vasorum are dilated, and the outer coat is more permeable to fluid exudations than is the middle. Under the microscope the diseased structure is found to be thickly set with small round nucleated cells, which lie parallel to the lamellæ. These cells are apparently derived from segmentation of the subendothelial corpuscles, but possibly some are white blood-corpuscles, which have migrated from the lumen of the affected artery.

(B) *Chronic Arteritis.*—Two varieties will be described under this head. (*a*) Chronic deforming. (*b*) Syphilitic.

Chronic endarteritis (arteritis deformans —atheroma) is a disease incidental to age, being seldom entirely absent after middle life. At the same time there is ample proof that the essential morbid change is inflammatory in nature, and further that it is largely dependent on mechanical strain. The evidence on the latter point, both positive and negative, is very conclusive. In the first place, as shown by Moxon, the large arteries are those usually affected; and when the medium-sized ones are involved, the splenic, coronary, and cerebral, which, from their anatomical disposition, are subject to continuous or repeated strain, are most likely to suffer. Again, the resistance to the local circulation offered by contracted granular kidney induces atheroma of the renal artery. Granular gouty kidney is known to be associated with thickening of the walls of the capillaries and smaller systematic arteries—*arterio-capillary fibrosis*, as it is designated by Gull and Sutton. The adventitia of these arteries is overrun with a hyalin-fibroid material, the tunica muscularis is hypertrophied, and the lumen encroached upon. The obstruction thus engendered gives rise to hypertrophy of the left ventricle, and raises the tension in the larger arteries. Chronic endarteritis is a constant sequel, and apoplexy from rupture of cerebral vessels a frequent termination. This form of vascular disease is more common in men than in women, and among the latter those accustomed to hard manual labour show it most.

Where large arteries pass beneath tendinous expansions or over bones—e.g. the femoral as it goes through the opening in the adductor magnus, and the iliac as it quits the pelvis—there chronic inflammation of the inner coat is wont to develop. Although the morbid process is common enough in the systemic arteries, it is almost unknown in the pulmonary, except where the right side of the heart is hypertrophied from bronchitis and emphysema, or stenosis of the mitral orifice.

Morbid Anatomy.—Chronic endarteritis commences in the deeper portion of the internal coat. The increased bulk causes the intima to rise in the lumen of the artery, so that the general uniformity of surface is broken by irregular elevations which, for the most part, lie with their long axes in the course of the vessel. The direction of the patches is determined by the line of greatest strain. In the aorta it is very manifest, especially when contiguous patches have coalesced. The branches, where they come off from the main trunk, are very liable to invasion, and, by the lateral extension and fusion of isolated patches, ring-like elevations may come to encircle them. In the event of the new tissue undergoing cicatricial contraction, the vessel is constricted—it may be, to obliteration of its lumen.

The elevations before referred to, are, in the first instance, pale yellow and but slightly raised. In the course of growth they assume a grey semi-translucent appearance, and frequently reach a tenth of an inch in thickness. To the feel they are inelastic, quite firm, or even of cartilaginous density. As yet they are smooth on the surface, the endothelial covering being retained. Sooner or later the patches turn yellow in the centre, owing to fatty degeneration of the inflammatory deposit, for there is no formation of blood-vessels in the new tissue. At the same time their consistence is diminished—it may be, even to fluidity. The cavity holding the softened débris is called an '*atheromatous abscess*'; the term, however, is a misnomer, for under the microscope the contents are found to be composed of fat molecules and their derivatives, cholesterine and stearic acid, the former appearing in the form of plates, the latter as acicular crystals. On rupture of the pellicle bounding the 'abscess' on its inner surface, the contents are washed out by the blood-stream and carried into the general circulation, but as the particles are very minute and non-infective, they do not usually give rise to symptoms.

The excavation thus made in the wall of the artery is termed an '*atheromatous ulcer*,' a name not warranted by the nature of the proximate lesion, which is degenerative, not suppurative. There is now opened up the possibility of formation of a dissecting aneurism, but such an event is rare, for the antecedent inflammation has served to weld together the middle and outer coats and the several lamellæ of each. Except in cases where the adventitia is little developed, as in the arteries of the brain, and the intra-pericardial portion of the aorta, rupture is not to be anticipated, for the neoplasia in the outer coat is not subject to fatty softening; moreover, as the perivascular tissue is condensed, and adherent to the wall of the artery, an additional safeguard is furnished.

But the formation of an 'atheromatous abscess' is not a necessary sequel to fatty disintegration of the inflammatory overgrowth. The products of degeneration may remain as a cheesy pulp—hence the name *atheroma*, which is commonly used, however, to indicate the entire disease—or be converted into calcareous plates by the deposition of lime-salts, a process sometimes referred to as '*ossification*,' although there is no production of true bone.

The morbid change which begins in the inner coat implicates, sooner or later, the middle and outer; elasticity and contractility are lost, and the vessel is converted into a thickened, rigid tube. Atheromatous arteries are generally dilated and elongated, for, having lost their power of recoil, they yield before the distensile force of the heart. By reason of their elongation they are thrown into permanent curves, a fact that should be borne in mind during the operation of ligature, especially of the external iliac, which often dips into the pelvis. The rigidity and curvature explain the 'locomotive pulse.' The above-mentioned alterations in structure and appearance are aptly expressed by the term 'endarteritis deformans.' Atheromatous softening and calcification of the inflammatory deposit are inversely proportionate to the smallness of the vessel. In the arteries of the brain, for example, although the muscular coat is frequently calcified, and the outer greatly thickened by fibroid overgrowth, caseation of the intima is much less marked than in the aorta and other large arteries, where rapid breaking down and cretification of the new formation are constant.

Microscopy of Chronic Endarteritis.—The deeper part of the internal coat is infiltrated with rows of small round cells lying parallel to the lamellæ. The lamellæ themselves swell up and become indistinct, whilst they are evidently thickened by fresh fibrinous deposit. As the disease advances, the muscular layer is involved and its contractile cells are destroyed. Neither does the adventitia escape, but the process here is mainly or entirely plastic. The proportion of cellular and homogeneous deposit varies considerably, but the latter is generally in excess. As the new growth loses its vitality it disintegrates through fatty degeneration. The cells become granular and break up into molecular débris, which then calcifies or undergoes complete liquefaction. In the latter event cholesterine forms and crystallises out as thin plates. If a calcified patch be treated with dilute hydrochloric acid, and the residue examined under the microscope, it will be seen to consist of amorphous granules and fragments of glassy or faintly fibrillated tissue.

Results of Chronic Endarteritis.—(1) Thrombosis and embolism. (2) Narrowing and occlusion of branches. (3) Aneurism.

(1) *Thrombosis and Embolism.*—Thrombosis is apt to occur about calcified plates, which, having broken away at their edges, act as foreign bodies, and offer resistance to the flow of blood (*see* THROMBOSIS). Embolism may have its origin in the detachment of calcareous splinters, or of thrombi formed in the artery. Gangrene at the part supplied by the embolised or thrombosed vessel is to be feared.

(2) *Narrowing and occlusion of branches.*—One or more of three factors is concerned. (*a*) Encroachment on the lumen of the swollen intima. (*b*) Contraction of plastic lymph in the adventitia. (*c*) Pressure of an aneurism of the parent vessel. Obliteration is completed by thrombosis.

(3) *Aneurism.*—Chronic endarteritis is a fertile source of aneurism. Although the walls of an artery may be greatly thickened, their power of resistance is diminished, from loss of elasticity. Rupture of an 'atheromatous abscess' does not materially weaken the artery at that point, but it allows the full force of the blood-stream to act over a wider area of softened tissue. *See* ANEURISM.

Syphilitic Arteritis.—How far syphilis is directly accountable for disease of the large arteries is a debated point. Aitken believes that it is a common cause of chronic arteritis, and certainly the fact that most of the cases of pathological aneurism in young subjects have a history of syphilitic taint lends weight to this opinion. It cannot be doubted that the virus of syphilis lowers the vitality of the coats of the arteries, as it does that of other tissues, and in this way it may lead to premature decay, and so predispose to inflammatory lesion. Syphilitic disease of the cerebral arteries is a not infrequent cause of thrombosis. It occurs in the shape of gummatous deposit in the outer coat and perivascular sheath; and as a proliferating change in the intima (Heubner), one or other form predominating. Arteries so affected look like dull-white threads or cords, and on examination are found to be much more solid than natural. It is easy to see how the swelling within the vessel, and the pressure without, must narrow the lumen, and obstruct the blood-current.

Barlow has described profound changes in the cerebral arteries of children suffering from congenital syphilis, of the same kind as those recorded by Heubner in the acquired disease. The new growth in the inner coat of the artery is made up of large nucleated cells. All the coats are involved, but the principal change takes place in the intima.

Periarteritis, or inflammation of the outer coat and areolar sheath, occurs under the following forms:—(1) Gummatous exudation into the lymphatic sheaths of the cerebral arteries. (2) Ulceration of a branch of the pulmonary artery skirting a phthisical cavity. (3) Arteritis by spreading of the inflammation from surrounding tissues, as when an artery becomes involved in periphlebitis, or in deep-seated suppuration.

Periarteritis may end in resolution, without local consequences; but there is danger of thrombosis, aneurismal dilatation, and rupture.

II. Degeneration.—(*a*) Fatty degeneration has already been mentioned in connection with atheroma, where it constitutes an essential part of the morbid process, giving rise to softening and disintegration of the new formation. In this case it is secondary to inflammation. But it occurs widely distributed as a primary change. Thus, in the large arteries, especially the aorta, it affects the stellate subendothelial corpuscles of the intima. It here appears as bright yellow spots or streaks, slightly raised above the surface, and smooth or finely downy. The deeper structures remain intact. It is found at all ages, even in very young children. It is of no clinical significance.

Of far graver import is the fatty degeneration so constantly met with in the cerebral vessels late in life. The adventitia receives the brunt of the mischief, but fat-molecules may be observed scattered through all the coats. As the result of softening, the small arteries burst under the blood-pressure.

In disused or paralysed limbs, the arteries show fatty degeneration of the contractile fibre-cells of the middle coat, and of the connective-tissue corpuscles of the inner and outer.

(*b*) *Calcification* is an important feature in chronic endarteritis, where, as before said, calcareous plates are the abiding mark of previous inflammation and softening. Primary calcification is very common in the medium-sized arteries—e.g. the cerebrals and tibials—of old people, or in those where the middle coat is well developed. Lime-salts are deposited first in the muscular fibre-cells; and, as these lie athwart the vessel, there results a series of streaks or rings which encircle it—*annular calcification.* By lateral extension these rings join and form a rigid cylinder—*tubular calcification.* The process is not confined to the middle coat, for it extends to the others, causing great irregularity and roughness.

The lumen of the artery is diminished. There is a great tendency to bilateral symmetry. The affected vessels, where superficial, can be felt as incompressible cords.

(*c*) *Amyloid degeneration* of the small arteries can be seen in tissues and organs affected with albuminoid disease. It conduces to hæmorrhage, and thus becomes of surgical interest.

III. Atrophy of Arteries forms a part of general and local wasting. According to Virchow, all the vessels are atrophied in chlorosis. If the femoral artery be ligatured for popliteal aneurism, the portion between the ligature and the aneurism, although not obliterated, shrinks to less than half its normal dimensions. The lumen is narrowed, and the coats are reduced in thickness.

IV. Hypertrophy of Arteries.—True hypertrophy occurs in the collateral branches after ligature of the main trunk. The walls are thinner than natural, owing to the dilatation consequent on the rise in the blood-pressure, but still the bulk is increased.

The small arteries are hypertrophied in granular kidney.

V. Raynaud's Disease.—Local asphyxia or symmetrical gangrene, are names given to phenomena which arise out of disturbance of the nervo-muscular dynamism of the small and medium-sized arteries. The subjects of this disturbance are not uncommonly young children, hence the expression *gangrène juvenile,* to indicate one of the pathological accidents of the disease. The fingers, toes, nose, and ears are the parts mostly implicated. The skin is cold, and sometimes cyanosed—*local asphyxia.* At others it is pale and marble-like—*local syncope.* The arteries are not diseased, but together with the capillaries and small veins they are subject to severe and prolonged spasm. The difficulty of the circulation may be so great as to cause gangrene.

As concomitants we may mention the occasional occurrence of erythematous eruption on the skin on different parts of the body, and renal hæmorrhage. The excitability of the vaso-motor centres in the spinal cord is exaggerated, and the irritability of the sensory nerves is increased.

VI. Arterial Embolism has been noticed under 'embolic arteritis' and 'atheroma.' The following are its sources:—

(1) Vegetations, simple or infective, detached from the cardiac valves. (2) Blood-clot dislodged from an aneurismal sac, or from an atheromatous artery. (3) Calcareous plates from the large arteries. (4) Portions of a new growth which has invaded an artery. (5) Venous thrombi in the case of the pulmonary artery.

The results are according to the size and nature of the embolus, and the state of the collateral vessels; thus embolism of the pulmonary artery may be suddenly fatal; embolism of the tibials may lead to secondary thrombosis and gangrene; infective embolism may give rise to aneurism, or, less probably, rupture.

VII. Arterial Thrombosis.—The blood may coagulate in the arteries from (1) Laceration of the coats, as in ligature.

(2) Embolic plugging (*see supra*). (3) Continued spastic contraction (see *Raynaud's disease*, above). (4) Hyperinosis, coupled with cardiac failure, as in the case of an acute fever. (5) Disease of the vessel, e.g. syphilitic arteritis and atheroma. Diffuse thrombosis of the tibial arteries is one cause of senile gangrene. Diffuse thrombosis of a large artery—e.g. the femoral—is usually followed by a similar process in the companion vein; gangrene is then inevitable.

VIII. Tumours.—Tubercle is never seen in the walls of arteries, although the perivascular tissue is one of its favourite sites. Malignant tumours occasionally invade an artery, and project into the lumen; but it is surprising how long this is resisted. Syphilitic gummata are found in connection with the cerebral arteries, but strictly speaking they are not new growths.

Augustus J. Pepper.

ARTERIES, Rupture of.—An artery may be ruptured partially or entirely; and either subcutaneously or in an open wound.

Partial Rupture.—In this injury it is the internal, or rather the internal and middle coats that give way.

Instances of partial rupture are met with—(1) In the operation of ligation of an artery. (2) From sudden strain, e.g. during an attempt at reduction of an old dislocation, especially of the shoulder-joint. (3) In crushing of a limb, the vessel being ground against the underlying bone. (4) From the application of violent external constriction combined with traction, as in judicial hanging.

The disposition of the inner and middle coats at the seat of laceration will vary according to the presence or absence of disease of the vessel, and the mode of injury. In simple ligature of a healthy artery the coats are as cleanly divided as though they had been cut with a knife, both in the living and dead subject. At the same time there is very little gaping, and no curling up within the lumen of the vessel, since the tendency of the inner to recoil with the middle coat is insufficient to tear it from its connection with the outer. But when the force employed crushes or twists the artery, the inner coat is raised from its bed, and by virtue of its elasticity it retracts and become rolled upon itself, at the same time that it is drawn inwards by the circular fibres of the muscular coat. Thus a flap-like valve is formed, which arrests or obstructs the current of blood, exactly as happens in torsion.

In chronic disease of an artery the inner coat loses its elasticity, and the middle its contractility, through fatty and calcareous degeneration, whilst all three coats are frequently so blended by fibroid overgrowth as to be practically inseparable. On the other hand the injury may light upon a patch of softening, and tearing through its inner wall lay the foundation of dissecting or other form of aneurism.

The results of Partial Rupture are (1) thrombosis; (2) gangrene; (3) aneurismal dilatation; (4) subsequent complete rupture. Partial rupture, *per se*, usually ends in thrombosis and permanent occlusion, as in ligation; but, as stated above, gangrene may ensue from the combined effects of obstruction in the main artery and the pressure of blood extravasated from a number of smaller vessels. Wide-spread arterial disease conduces to a like result, the rigid anastomosing arteries not dilating in time for the collateral circulation to be established.

Diagnosis of Partial Rupture, when the vessel is comparatively superficial, as it commonly is:—(1) Look for arrested or diminished pulsation in the arteries on the distal side of the seat of injury; (2) examine for a small, more or less firm, circumscribed swelling below where the artery continues to beat; (3) ascertain if the difficulty in the circulation is greater than can be accounted for by the extravasation of blood from small vessels in the muscles and cellular planes of the limb.

Treatment.—Wrap the limb in cotton wool, place it upon a pillow, between sandbags, in a semiflexed and slightly elevated position. Bandages had better be dispensed with, on account of the danger of still further embarrassing the circulation. If gangrene supervenes amputation must be resorted to. If the rupture becomes complete later on, the treatment will be as hereafter advised.

Complete Rupture may occur by avulsion of a limb. The bleeding under these circumstances is less than might be expected, for the internal and middle coats are torn from the outer, and contracting and retracting curl up within the vessel; and the outer coat and the sheath of the artery are folded or twisted over them. Hæmostasis is furthered and may be completed by the formation of a clot. The rupture is termed complete, when the wall of the artery is torn through in one part or throughout its whole circumference. In either case it may take place subcutaneously, or accompany a lacerated wound of the soft parts. It may be complicated, amongst other accidents, by simple or compound fracture.

Subcutaneous Rupture without fracture.—The arteries most commonly injured are the popliteal and the axillary; the former from a violent wrench of the leg, the latter during the attempt to reduce an old luxation of the shoulder-joint. The disaster is immediately followed by severe pain in the part, and this by numbness of the limb, which as a rule the patient is unable to use to any extent. The latter symptom, however, is not constant, either as regards its onset or degree. Pulsation ceases or is much weakened in the arteries beyond, the exact issue turning upon the amount of extravasation, and whether the rupture has involved the entire vessel or only a segment of it. The limb is colder than its fellow, the temperature rapidly falling. Blood escapes from the rent and collects around the artery, forming a tense swelling, or it is driven far and wide among the surrounding tissues; the result varying according to the size of the vessel, the size of the opening in it, and the resistance offered by adjacent structures. Pulsation is mostly absent, and when present it is generally over a limited area. Possibly a loud or subdued bruit may be heard, but it is not conducted along the course of the artery with the same frequency and distinctness as when generated in a pathological aneurism.

Treatment.—The surgeon will be partly guided by the condition of the limb as to the amount of bruising and extravasation. If gangrene has set in, amputation must be performed at once. The liability to gangrene is more remote in the upper than in the lower extremity, and the possession of the arm more essential to the patient than the leg; hence, every attempt should be made to save it. If in rupture of the brachial, radial, or ulnar artery, the extravasation has ceased and is not very extensive, compression should be applied at the seat of injury and over the main vessel higher up.

Under opposite conditions, and also in cases where the diagnosis is doubtful, it will be safer to cut down, turn out the clot, and ligature the artery on each side of the opening in it. The limb should be raised to empty the vessels, and then Esmarch's cord be applied. If difficulty is experienced in finding the ends of the vessel, the tourniquet should be loosened, to allow a jet of blood to escape; or a little dissection made in the course of the artery.

Rupture of the main artery in the lower limb generally calls for primary amputation, but if gangrene has not commenced, and the soft parts are not too extensively damaged, double ligature should be resorted to in the first instance, especially when the patient is young and the vessels presumably free from disease. Augustus J. Pepper.

ARTERIES, Wounds of.—When hæmorrhage is severe, it is generally found that its source is a wounded artery. A vessel may be completely or only partially divided. In the latter case the damage may consist in the artery being split, or in a transverse cut involving a part only of its circumference. Notwithstanding the comparative rareness of these partial divisions, they are of extreme interest to the surgeon, as furnishing a considerable contingent of cases of persistent recurrent bleeding. The explanation as to why the hæmorrhage is so persistent in such cases is to be sought in the anatomical structure of an artery, and by consideration of the process by which nature arrests the hæmorrhage of a completely divided vessel; for if it be remembered how important the contraction and retraction of the vessel are in arresting the hæmorrhage in such a case, it will be seen that the same mechanism causes the opening to gape and remain patent when the vessel is only partly divided. If it be known that a vessel is only partly divided, its division should be made complete, and its ends ligatured.

The details of the treatment of wounded arteries are described under the headings of the special vessels; but, before considering these, it may be well to discuss briefly the general principles on which the treatment of arterial hæmorrhage is conducted, the treatment, in great measure, depending on whether the hæmorrhage occurs from an incised or a punctured wound.

Treatment of Arterial Bleeding in Incised Wounds.—Bleeding vessels should always, if possible, be secured *in situ*. As a rule there is little difficulty in picking up the bleeding artery. Occasionally, however, owing to the bleeding artery lying deeply in the angle or apex of the wound, it cannot be readily secured with the forceps, or it sometimes happens that, owing to the vessel having retracted, the bleeding point itself cannot be seen. In these circumstances a little careful enlargement of the wound, in the direction of the bleeding, will enable the vessel to be secured. Occasionally, especially in wounds of the scalp, it is a better practice to treat the retracting vessel by pressure, or by a harelip pin passed beneath it, than to make anything like a cross-cut to search for it.

A few years back several methods were advocated for securing divided arteries: thus, in preference to the ligature, some surgeons advocated various forms of acupressure or torsion. The advantage of these consisted in avoiding the septic track caused by the ligatures, the ends of which were always allowed to hang out of the wound. Since the introduction of the catgut ligature, which, after the ends are cut off, is left in the wound, such objections have entirely disappeared, and ligatures either of gut, tendon, or Chinese silk, are almost universally employed, and are, by far, the simplest and surest agents for closing the vessels. In some rare cases in which a diseased vessel will not hold a ligature, acupressure may still be usefully employed.

The surgeon, on being sent for to a case of hæmorrhage from an incised wound, will generally find the part wrapped round with handkerchiefs or towels partially soaked with blood. Before removing these, which may have served temporarily to restrain the bleeding, the patient should be gently lifted on to the edge of a bed or couch in a good light. This matter of light is of the utmost importance, making all the difference between success and failure in picking up the vessels. Should the wound be on one of the limbs, a tourniquet, or the finger of an assistant, must be placed in readiness over the main vessel—the femoral or subclavian as the case may be—but pressure is not exercised until required. A basin, a sponge, and cold water being placed handy, all wrappings are rapidly removed from the wound. All clot must be cleanly sponged out, and any vessels that can be seen to be divided, whether bleeding or not, should be tied. If alarming bleeding well up from a main vessel at the bottom of the wound, the finger must be placed over the bleeding point, when a little dissection, with the back of a knife or director, will bring the vessel into view above and below the bleeding point, and two ligatures can be applied with an aneurism-needle. When the bleeding has been arrested, the edges may be brought together in the usual manner.

Treatment of Arterial Bleeding from Punctured Wounds.—Straightforward and easy as may be the treatment of hæmorrhage from incised wounds, the course to be adopted for the arrest of arterial bleeding from punctured wounds forms a grave and complicated question.

The writer believes that the arbitrary rule, that 'in every instance the wound should at all hazards be laid open, and the vessel secured at the bleeding point,' is far too dogmatic, and has led to severe and even fatal operations, many of which were wholly unnecessary.

Without doubt the general acceptance of the principle of searching for the wounded artery has been due to the writings of Guthrie, who in forcible language taught it, to the exclusion of all other forms of treatment. His teaching quickly permeated medical literature, and it soon came to be considered that the surgeon who failed thus promptly 'to look his enemy in the face,' showed timidity, or a want of knowledge in the first principles of his profession.

Surgeons who have performed or witnessed the operation necessary for the securing of the tibial, deeply situated in a punctured wound, will know that Guthrie's description of the ease and certainty of this operation is not merely inaccurate, but misleading, as entirely opposed to the actual facts. Thus Arnott, in his well-known case of ligature of the tibial in a punctured wound, says: 'It is not an operation that should be undertaken inconsiderately, for it requires a good light and intelligent assistance. The case described occurred in the day-time, and from what was experienced I am inclined to think that it could not have been successfully performed under artificial light.'

So eminent a surgeon as Dupuytren readily recognised that the search for wounded vessels deeply situated in a muscular calf was a procedure surrounded by practical difficulties, for, says that author, 'to all who know the depth of these vessels, their relations to the bones, nerves, and muscles, the scheme of cutting down upon the vessels appears impracticable. How could they be distinguished from the soft torn bruised parts which surround them, or how could a ligature be passed and tied at the bottom of a wound deep between the bones?'

It is often argued that, because the treatment of hæmorrhage from an incised wound is so easy, and that from a punctured one so complicated, by converting the one into the other all difficulties will disappear. The fallacy of the assumption that in all cases the characteristics of an incised wound can be given to a punctured one by its mere enlargement, becomes obvious on reflection.

Punctured wounds must of necessity be inflicted by small missiles or narrow instruments, which can penetrate to positions inaccessible by a simple incision. Their direction and depth are often quite unknown, consequently the position and size of the bleeding vessel is a matter of mere speculation. The bleeding point may be, and often is, far away from the external wound, possibly on the opposite side of the limb, so that a very deep and extensive incision has to be inflicted to secure what may ultimately prove to be an unimportant arterial twig. If, of course, it could be shown that by enlarging the wound the vessel could be secured with little difficulty or risk, while on the other hand, similar forms of treatment commonly resulted in failure, the cutting down doctrine might be accepted in its entirety. Experience, however, leads to an opposite conclusion, and shows that not only the search for the wounded vessel at times proves ineffectual, but that all bleeding might have been permanently arrested without the necessity of any operation.

Guthrie's rule for the treatment of arterial hæmorrhage has purposely been criticised, but it must not be inferred that this plan is never applicable. A wound may be so situated, or the limb in such a condition, that it becomes the safest and most practicable method; but it is specially urged in this article, that the surgeon will best consult the interest of his patient who remembers that the procedure is not to be regarded as a trifling one. For however simple and easy it may be at times, it at others involves a hazardous operation, not to be undertaken without a full conviction of its necessity.

If the surgeon requires any rule, it should rather be that in punctured wounds, unless the exact source of the bleeding is obvious, the careful and even application of pressure should be first tried, reserving active operative interference until so simple a procedure as pressure has proved ineffectual. The surgeon must not allow his judgment to be warped by fear of the failure of the pressure which he employs, and the possibility that he may have to fall back too late on the cutting plan; but he must consider what on the whole is the simplest treatment, and that which is most likely to be successful with the least risk to his patient. The details of treatment will vary according to the locality of the particular artery injured, and are fully considered under the headings of the various vessels. But it may be well before discussing these to consider the general plan of treatment.

Treatment.—The surgeon is hurriedly sent for to a patient who is said to be bleeding to death from a punctured wound. On arrival it will generally be found that natural alarm at the sight of blood has led to the extent of the bleeding being greatly exaggerated, 'the torrents of blood' often meaning but a few ounces. The state of the patient's pulse and his general appearance will usually afford a safe basis for the estimate of the extent of the bleeding; moreover, the effect produced upon the patient is more important than the actual quantity of blood lost. If the collapse be not severe the patient should be at once lifted upon a convenient couch or bed. This should be done with the greatest care and gentleness, the patient being kept in the recumbent position, and on no account allowed to make the least muscular exertion. Bearing in mind what has been stated elsewhere as to nature's process of stopping hæmorrhage, it will be understood that it is of the utmost importance to prevent the blood-coagulum, which has very probably temporarily formed during the period of collapse, from being again broken up by the force of the heart's action—a risk incurred by any exertion on the part of the patient. *See* HÆMORRHAGE.

The cloths and bandages generally found wrapped round the wound must be removed in a good light. The next steps to be taken will depend on whether the bleeding has ceased or is still continuing.

TREATMENT WHEN THE BLEEDING HAS CEASED.—The parts in the neighbourhood of the wound can be gently cleansed of blood with a soft sponge and warm water. But the clot itself seen in the wound should on no account be disturbed, the orifice being simply covered with a couple of folds of lint wetted in cold water or carbolic lotion. The patient should be lightly covered with blankets, in such a way that the wound covered by the lint is exposed, so that any recurrence of bleeding can be at once detected. It is better in these cases, where the bleeding has actually ceased, to apply no pressure, either directly on the wound or indirectly on the course of the vessels, for fear of disturbing the arresting clot.

The clothes if dry may be simply loosened; otherwise they must be cut off, clumsy attempts to remove them being often followed by a fresh bleeding. There is no period when the most absolute rest is so necessary as in the first few hours after a severe bleeding which has spontaneously ceased, for the coagulum that has formed during the collapse is constantly growing stronger by extension within the vessel, and, if time be allowed, will form an effectual barrier before reaction occurs. This rest, so imperative at first, must be enforced, though not perhaps quite so rigidly, for several days, and the patient should, on no account, be allowed to leave his bed till the external wound is soundly healed. Want of precaution in this respect is a common cause of traumatic aneurism, unnecessary intra-arterial pressure being put on the sealed end of the vessel before it is sufficiently consolidated to stand it.

Treatment when the Bleeding is continuing.—If the wound be situated in one of the limbs the bleeding must be at once controlled by pressure, either digitally or by the tourniquet on the main artery. In the upper extremity the brachial can be compressed against the middle of the humerus, if the wound be in the forearm or hand. If the bleeding come from a higher point, the subclavian must be compressed. In compressing the subclavian the finger or thumb cannot be relied on except for a short time, a piece of wood or a small poker, covered with lint, being far more effectual.

The femoral artery is best controlled as it crosses immediately beneath Poupart's ligament, its course in this situation lying midway between the symphysis and the anterior superior spine. The mistake very commonly made is that of applying pressure an inch or two below the ligament, a position in which much more force is required to control the vessel than need be applied at a higher point.

The bleeding having been thus temporarily controlled, time is gained for considering the best course to be pursued for its permanent arrest. If the wound is known not to be deep, from the nature of the instrument inflicting it, and moreover, if it is situated over the main vessel of a limb where that vessel is naturally superficial, as in Scarpa's triangle, or along the course of the brachial, or in a position such as in the middle of the neck, where effectual pressure is impracticable, the wound may be enlarged, and the vessel sought for at the injured point.

On the other hand, if the wound be of unknown depth, and in a position in which the main vessels are deeply situated, as in the lower half of the thigh, the calf, the forearm, and the hand, pressure should certainly be tried before resorting to an operation.

Method of employing Pressure.—In order that pressure may be successful in permanently restraining the bleeding it is well to bear in mind the following points:—

1. That blood may be furnished at either end of the divided artery.

2. That pressure is not only required over the wound, but along the course of the artery, both above and below it.

3. The pressure must never be entirely concentrated at a single point, but disseminated along the course of the vessels, for, by distributing the pressure, much less is required to arrest the bleeding than if it be applied on the wound alone.

4. That the whole quantity of blood circulating in the limb can be lessened by careful bandaging from below upwards.

The methods of applying pressure require modification in particular situations, and will be found under the headings of the different vessels. But the following is the general principle.

The bleeding being temporarily arrested by the tourniquet, the wound must be gently washed and sponged as dry as possible. A conical pad, made of from sixty to eighty separate pieces of lint, the smallest the size of a sixpenny bit, the largest an inch and a half in diameter, is applied directly over the wound, and kept in position by two narrow pieces of X strapping. The limb is then very evenly bandaged with a domette roller from the toes or fingers upwards as high as the conical pad. The pad being left uncovered, the bandage is continued upwards to the shoulder or groin, ending off with a spica. Two compresses, prepared by winding strips of lint round a firm foundation, such as the half of a pencil or penholder, are now laid along the course of the main vessel, both above and below the wounded point. These roller-like compresses must be firmly applied and kept in position by separate bandages. Lastly, another narrow bandage is wound round the limb over the conical pad, to exert pressure upon it.

It is a good plan in some situations to have a broad, well-padded splint on the side of the limb opposite to the rollers and pad, so that the bandages which keep them in position do not exert a circular pressure entirely round the limb.

There is great advantage in having the rollers and pad kept in place by three distinct bandages. By this arrangement any one of them may be loosened or tightened, as the case requires, without disturbing the others, which is a matter of considerable importance. The next question which arises is as to the length of time the pressure should be employed.

So long as the circulation has been fairly carried on in the limb—a point easily ascertained by momentarily compressing the capillaries of the toes or fingers—pressure can be maintained without risk of gangrene. It is very desirable to keep up a moderate amount of compression for a considerable period—an object to be attained by taking great care that it be not too much concentrated at any single point, for, if a bandage be too tight at any spot, not only will it cause pain and restlessness, but it is liable to produce sloughing of the skin. If possible, the firm pressure first applied should be maintained for eight or twelve hours. If pain or discomfort be then complained of, a judicious snip of the bandage here and there at any points which appear to be too tight will give relief. In this way a diminishing amount of pressure can be maintained for several days. Speaking generally, in primary hæmorrhage, if the bleeding has been arrested for twelve hours, the clot within the vessel will have acquired sufficient consistency to prevent its recurrence. During the treatment absolute rest in bed is essential, and the limb should be raised on pillows to a comfortable height.

Occasionally, notwithstanding every precaution and care in the trial of pressure, hæmorrhage will recur. In these circumstances it is possibly due to the premature slipping of one of the pads or bandages, so that it would be right to give it one more trial before abandoning it as useless. Should this second attempt fail, or the limb be in such a condition as to forbid a second trial, the wound should be enlarged and the bleeding-point sought for, with the exception of wounds in a few localities to be described.

Search for the Wounded Vessel.—The patient, under an anæsthetic, being placed in a good light—a matter of the utmost importance—the surgeon passes his left forefinger into the wound, and, if necessary, enlarges the orifice with a probe-pointed knife sufficiently for the purpose. By a little manipulation it can be ascertained when the point of the finger controls the hæmorrhage. A straight probe-pointed knife is then passed down by the side of the finger, and the wound boldly enlarged to a sufficient extent both upwards and downwards. The length of the incision thus made will depend on the depth of the wounded artery, and may have to be six or seven inches in length. The cut must always be made in the line of the limb, a transverse or ⊤ cut being, if possible, avoided. Cross-cuts seriously interfere with the vitality of the margins of the wound, and, if extensive, may even imperil the limb itself, from the severance of the collateral circulation.

Harrison Cripps.

ARTERIOTOMY.—The operation, now rarely performed, of opening an artery for the purpose of general blood-letting. The trunk of the temporal artery as it crosses the zygoma, or its anterior branch as it passes on to the forehead, are ordinarily the only vessels suitable. In consequence of the extreme ease with which pressure can be applied over it, the anterior branch should be selected, unless it is abnormally small.

Apparatus required.—Lancet or small scalpel, graduated bleeding-bowl, firm compress of lint, narrow bandage, water and sponge.

Operation. — The vessel having been fixed by placing the finger or thumb on it a little to the distal side of the spot selected for the incision, should be cut down upon and laid open transversely until it has been about half-divided; the necessary amount of blood having been taken, as shown by the graduations on the bleeding-basin, the artery should be completely cut across, the compress applied and retained in position by the bandage. At the end of forty-eight hours strapping may be substituted for the bandage, but the compress itself must not be disturbed till the fourth or fifth day, when the wound should be healed. The complete division of the vessel before the application of the pad is important, in order to more certainly avoid (1) secondary hæmorrhage, and (2) consecutive aneurism. William H. Bennett.

ARTERIO-VENOUS ANEURISM. Under this term are included all cases of abnormal communication between an artery and a vein.

1. *Causes.*—Arterio-venous aneurism is generally traumatic in origin, and the most frequent cause has been phlebotomy; next in order of frequency is gunshot injury, and then stabs and similar punctured wounds. In one case prolonged compression of the femoral artery for the cure of an aneurism on the posterior tibial trunk was followed, ten months later, by an arterio-venous aneurism at the point of compression. In other cases, also, the aneurism has only developed at a long interval after an injury —even as much as twelve or even thirty years. There is another group of cases in which the abnormal communication has occurred spontaneously without any previous injury; many of these are to be regarded as instances of the rupture of an aneurism into an adjacent vein. Since venæsection has become a comparatively rare operation, and always entrusted to skilled hands, this form of disease has

become much less common. It is met with in connection with small arteries and veins, such as the branches of the sciatic vessels in the great sciatic nerve; medium-sized vessels, such as the temporal, occipital, and posterior tibial; or large vessels, as the popliteal, femoral, iliac, brachial, carotid, and even the aorta itself.

2. *Pathology.*—The arterio-venous communication is generally between vessels lying closely side by side; but this is not always the case. At the elbow, for instance, the communication is commonly between the median-basilic vein and the brachial artery; in the neck, arterio-venous aneurism of the external carotid artery and the internal jugular vein has been observed. According to the character of the arterio-venous communication cases of this disease have been divided into two classes, and the division is of much practical importance. Where the two affected vessels are firmly adherent together, with a large or small aperture through the walls where they are in close contact, and the blood passes directly from the artery to the vein, the condition is known as *aneurismal varix*, for the aneurismal tumour which is produced is, in fact, a dilated vein. In many other cases, however, there is a consecutive or a spontaneous aneurism developed in connection with the artery, which also communicates with a vein, and the condition is then known as *varicose aneurism*, the important feature of the case being the existence of a veritable aneurism. In *aneurismal varix* the aperture of communication between the artery and vein may in recent cases be slit-like, but in old cases it becomes rounded, with smooth, thickened edges. The artery above and below the aperture is considerably dilated, and its walls are thinned.

In some cases these changes have been most marked above the communication, and the vessel below has been described as contracted, while other observers have described the arterial changes as most marked on the distal side of the aperture into the vein; these changes may be met with at a considerable distance from the original lesion. The vein becomes greatly distended and pouched immediately opposite the opening into the artery, and its walls become thickened; these changes affect the veins for some distance, especially on the cardiac side of the arterial aperture, and they are not limited to the trunk immediately affected, but involve also the branches opening into it. Thus, in an aneurismal varix of the femoral vessels at the groin, the superficial epigastric, circumflex iliac, and external pudic veins were enlarged, as well as the femoral and internal saphenous trunks. In *varicose aneurism* the condition of the affected arteries and veins is the same as in aneurismal varix. In addition there is an aneurism. Where the aneurism is 'consecutive' or traumatic in origin it is usually of small size. In the cases of spontaneous aneurism with communication with a vein the tumour has generally attained a large size before it has, by the influence of continuous pressure, caused absorption of the wall of the vein. The openings of the artery and the vein into the aneurism vary in size and in relative position, sometimes being on opposite sides of the sac and at others close together. The sac of the aneurism contains only a small amount of laminated fibrin, even if any be present.

3. *Symptoms and Diagnosis.* — The symptoms common to all cases of arterio-venous aneurism are (1) the presence of a tumour with expansile pulsation synchronous with the action of the heart; (2) distension of the veins of the part on both the distal and the proximal side of the swelling; (3) a very marked purring or rasping thrill, which is felt at its greatest intensity over the arterio-venous communication, but is conducted for some considerable distance along the veins of the part. This thrill is continuous over the 'aneurism,' but is exaggerated by each cardiac systole; in the veins at some distance from the tumour it may be intermittent and systolic only. (4) A loud buzzing, hissing, or rattling murmur, heard loudest over the aperture in the vein, where it is continuous, but accentuated at each beat of the heart; the bruit is conducted for some distance along the distended veins, gradually becoming weaker and systolic only. This murmur may be audible to the patient and even to the bystanders, and, heard through a stethoscope, it may be of painful intensity. In addition, there is sometimes a soft blowing aneurismal murmur. Pressure over the swelling, just where the thrill and bruit are most marked, may abolish the thrill, and greatly lessen or abolish altogether the loud bruit, and these effects are believed to be due to the pressure being applied so as to close the opening into the vein. There may be severe pain from pressure upon the nerves of the part, or œdema from obstruction to the venous circulation. The peculiar thrill and murmur are the features which enable the surgeon at once to recognise an abnormal communication between an artery and a vein, and they are due to the passage of blood from the artery into the vein. If

the aneurism be deep, and the aperture into the vein be small, these signs may be absent, and the diagnosis be rendered impossible; and one case has been reported in which, from the small size of the artery involved, pulsation was not detected in the tumour.

The diagnosis between an aneurismal varix and a varicose aneurism may be impossible where the disease affects a deep vessel and the aneurism is small. Aneurismal varix is less formidable than a varicose aneurism, and its symptoms and the disturbance of the circulation it entails are less severe: it may remain stationary for many years, causing little inconvenience to the patient except the consciousness of the murmur and of the thrill. Varicose aneurism runs a more rapid course. If, when the artery leading to the swelling be compressed so as to arrest all pulsation, the swelling collapses completely without the application of any or of but very gentle compression, the affection is a varix; but if, on the contrary, when pulsation is thus arrested, the veins collapse, but a distinct tumour remains, which can only be emptied by compression, it indicates that there is an aneurism. Similarly in the cases where light pressure upon a particular spot stops the thrill and murmur, if it be found that by this means the swelling collapses, it is a varix; while, if there is still a swelling with expansile pulsation, it shows the case to be an aneurism. Where, in addition to the loud murmur characteristic of an opening into a vein, a soft systolic blowing bruit can be detected, it is strong evidence of the presence of an aneurism. This bruit may be only audible when the flow of blood into the vein is arrested by pressure over the aperture of communication. In some cases there is the history of a simple aneurism and the subsequent development of the characteristic thrill and bruit; in other cases, again, there is a history of an aneurismal varix becoming suddenly larger, more painful, and causing serious interruption to the circulation of the limb, from the formation of an aneurism. It is impossible to distinguish between these two affections in the orbit.

4. *Treatment.—Aneurismal varix*, as a rule, requires only palliative measures. The distended veins have thickened walls, which resist the force of the blood flowing into them from the artery, and after a while the swelling ceases to grow, and the patient is not exposed to the danger of its rupture. In such cases, external support by a bandage, or an elastic webbing made to fit the part, fulfils the indications for treatment. Should the varix be painful, or in any other way disable the patient, means for its cure may be adopted. Of the plans of treatment which have been suggested the best is the ligature of the artery above and below the communication with the vein: this operation is attended with unusual difficulty owing to the dilatation of both the artery and the affected vein.

In *varicose aneurism*, the existence of the aneurismal sac, with all the perils associated with that condition under other circumstances, necessitates curative treatment; and whether causing severe symptoms or not, so soon as the diagnosis of aneurism has been arrived at, careful attempts at its cure must be made. Several methods are open to the surgeon. Where by compression at one spot the characteristic thrill and bruit are lost, digital or instrumental compression of the main artery above should be combined with it; this sometimes proves quickly successful. Where it fails, or cannot be carried out, and the aneurism is on a limb, the patient may be anæsthetised, and an elastic bandage applied to the limb below and above the tumour sufficiently firmly to arrest the circulation completely. By this means the aneurism and the connected vessels are filled with stagnant blood: this alone may secure clotting, as in simple aneurism, or an electric current may be passed through the blood by means of needles inserted into the aneurism, or coagulants, such as perchloride of iron, may be injected into the sac. Electrolysis may be applied without previously arresting the circulation, but coagulants must never be injected unless this precaution have been taken.

Should coagulation be obtained by either of these means, the clot should be protected from the full force of the circulation by digital or instrumental compression of the main artery for two days at the least. When these measures fail, or cannot be carried out, an incision should be made over the tumour, in the line of the artery, and that vessel ligatured above and below the sac—if possible, without opening the aneurism. The application of a single ligature to the artery above the sac should not be practised in the limbs, as it has often failed to obtain a cure. In varicose aneurism of the orbit the proper treatment appears to be the ligature of the common carotid artery, and, should this fail to arrest the pulsation in the tumour, it should be followed by the direct application of electrolysis to the aneurism. *See* Orbital Aneurism.

A. Pearce Gould.

ARTERY-FORCEPS.—The object of an artery-forceps being to arrest hæmorrhage during an operation as rapidly as possible, it must necessarily be fitted with a spring or catch so as to hold its position when released by the surgeon's hand. The *serre-fine* or twisted wire of the French instrument-makers has never been a favourite with English surgeons, on account of its small size, but the larger metal clamp commonly known as the 'bull-dog' was formerly a good deal employed.

The *forci-pressure* forceps, introduced into practice by Sir Spencer Wells a few years back, has been largely adopted by operating surgeons, and has the great convenience that it is readily applied, and maintains its hold so thoroughly that, at the conclusion of the operation, the vessel is found to have been effectually occluded by the mere pressure; or, if not, it can be easily twisted with the same instrument, over which, also, a ligature can be tied if preferred. Köberle's forceps is practically identical.

For taking up arteries at the conclusion of an operation many surgeons prefer a pair of ordinary dissecting-forceps, by which the vessel is readily seized and drawn out of its sheath for the application of a ligature. But a ligature is not easily tied upon an artery held by such an instrument, since the blades are apt to be included in the knot.

Liston's artery-forceps, with expanded blades and sharp points, is a more generally useful instrument, and has the advantage of a spring-catch; but it is dangerous when applied too near a main trunk, which it may accidentally pierce, so as to give rise to further bleeding.

Asalini's forceps is kept closed by a spring, so that the pressure of the fingers is required to open it, and this must be again relaxed in order that the points may seize the vessel. A noose of ligature is usually placed around this forceps before it is applied, and is then slid down over the mouth of the vessel by those surgeons who employ it.

A *torsion-forceps* is made with broad serrated ends, and the blades are usually fitted with a sliding-button, by which they are approximated and held upon the artery to be twisted. There appears to be no reason why this inconvenient arrangement should not be replaced by a spring-catch, as in Syme's artery-forceps.

ARTHRITIS. *See* JOINTS, Diseases of.

ARTICULAR CARTILAGE, Diseases of.—The changes which originate in articular cartilage are mostly rather of the nature of degenerations than active disease; and inflammation of this structure is certainly, in most cases, secondary to affections of the synovial membrane, or of the joint-ends of the bones.

In acute inflammation of joints, especially of the septic variety, the articular cartilage often undergoes a rapid dissolution, which is undoubtedly due to the inflammatory disturbance of its nutrition. If such a joint be examined, it will be found that in addition to the swelling and vascularity of the synovial membrane, parts of the cartilage have undergone thinning, softening, or even entire removal, so that in some places the articular lamella of the bone is exposed, and in others the cartilage is loosened or detached.

In the more chronic forms of joint-disease, such as, for example, the scrofulous, the cartilage becomes inflamed and ulcerated in consequence of the encroachment upon it of granulation-tissue, either from the synovial membrane upon its surface, or from the bone beneath. From whichever surface the process may originate, the destruction of the cartilage is correspondent to the advance of the granulation-tissue. If from the synovial surface, the cartilage becomes thinned, pitted, roughened, and changed to a yellowish tint; the bones eventually becoming exposed, and undergoing a similar process of ulceration. If from the bone surface, the same changes occur on that side of the cartilage, large pieces of which may be detached as by a process of necrosis.

There is, moreover, another class of cases of joint-disease, in which the cartilages become early affected by the ulcerative process in consequence of the stimulus of a synovial inflammation, which, without having the extremely acute or irritative qualities of the septic form, is yet of a progressively destructive kind. In these cases the synovial membrane, though very vascular, is but slightly swollen or thickened, and the amount of fluid in the joint is usually but small, yet the cartilages are found to be extensively ulcerated, so that the articular lamella is exposed at a comparatively early stage of the disease. This form of joint-disease affects most commonly the hip-joint.

Microscopic examination of inflamed articular cartilage reveals the following changes:—There is, first, an increase in the size and number of the nuclei of the cartilage-cells, and absorption of the hyaline intercellular material; then, as the process goes on, the nuclei undergo granular degeneration, and those cells nearest the surface rupture and allow the escape of their nuclei; thus there ensues a loss of substance, and by the extension of the process the cartilage is gradually destroyed.

In the more chronic cases the cartilage may be seen to have undergone fibrillation rather than ulceration; or its destruction may be limited to the points at which the under- or overlying granulation-tissue has invaded it.

The *symptoms* of inflammation of articular cartilage are not in any way characteristic. The tissue is insensitive, and probably the spreading to it of inflammation from the synovial membrane or bone cannot be recognised until ulceration has occurred and the bone is exposed. When, however, this stage has been reached, the exposure and inflammation of the articular lamella gives rise to painful startings of the limb, which are greatly aggravated by any movement of the joint, and which become a prominent feature in the symptoms. This distressing muscular spasm is especially apt to occur just at the commencement of sleep, when, the voluntary control of the muscles being withdrawn, the sensitive bone-surfaces are drawn into acutely painful contact, and the patient awakes with a cry of pain. This is especially the case in disease of the hip-joint, and gives rise to the characteristic 'night-scream' of children thus affected.

The results of ulceration of the cartilage will vary much with the age and reparative power of the patient, the kind of disease with which it is associated, and the acuteness or chronicity of the process. If the disease is arrested before any considerable destruction of the cartilage has occurred, the surface may heal by the formation of fibrous tissue, which may merely fill up the gap, or may form an adhesion to a corresponding point upon the opposite surface of the joint. If the cartilage be extensively removed, either the joint will be destroyed by suppuration, or the destructive process coming to an end, there will be an effort at repair, and the opposed bone-surfaces will become firmly adherent by fibrous or osseous anchylosis.

In the *treatment* of ulceration of articular cartilage, rest and extension of the limb are primary essentials. Extension by a pendent weight, or suitable splints, will do much to prevent the painful muscular spasm described above; though occasionally this distressing symptom may necessitate tenotomy of the irritated muscles.

For the same purpose, also, the internal administration of opium, or the subcutaneous injection of morphia, is frequently necessary. The joint-disease (of which the ulceration of the cartilage is usually but a part) must, of course, be treated as a whole; but it may be added that in those cases in which the symptoms of ulceration of the articular cartilage are prominent or of early occurrence, counter-irritation, especially by the actual cautery, will usually be found to give great relief.

Besides the inflammatory affections above described, articular cartilage is liable to certain degenerative changes and disturbances of nutrition. A common condition in old people is a variable amount of fatty degeneration, in consequence of which the cartilage becomes thinned, roughened, and of a yellowish colour. In other instances fibroid changes occur, giving rise to a loss of smoothness and elasticity, generally with some atrophy. Such conditions, however, are not recognisable during life.

In gout a deposition of urate of soda takes place in the cartilage, interfering with its nutrition, and giving rise to wasting and calcareous degeneration.

Finally, in osteo-arthritis, the first changes are observed in the cartilage, which loses its proper smoothness, and becomes wasted and worn away at the points of greatest friction, while at the same time some irregular thickening occurs at its edges, where least subjected to pressure. *See* OSTEO-ARTHRITIS.

J. WARRINGTON HAWARD.

ARTIFICIAL ANUS.—The term artificial anus is applied to certain cases in which the lumen of the bowel communicates with the surface of the body through a breach in the intestinal wall. This communication may be met with under many different conditions, but to all such the present term is not applicable. In artificial anus the aperture in the gut is large, and opens directly upon the cutaneous surface of the body; the bowel is practically, if not in fact, connected with the integuments, and the escape of fæces is thus direct, and not through an intermediate fistulous passage. In other instances there is a communication between the lumen of the bowel and the cutaneous surface, but it is not direct. The gut in which the abnormal aperture exists lies at some distance from the surface, and between the bowel and the skin stretches a long fistulous passage, or a large abscess cavity intervenes, or the communication between the two parts is still more indirect. To these instances the term fæcal fistula, or stercopurulent fistula, is applied. In other cases again the bowel communicates with a mucous cavity such as the bladder or vagina, but to such examples the terms vesicointestinal and vagino-intestinal fistula are applied. The term artificial anus, therefore, is used in but a limited sense; the limitation is arbitrary, and is based upon therapeutic grounds. The methods available for the treatment of artificial anus on the one hand, of vesico-intestinal and allied fistulæ on the other, and of fæcal fistulæ, so called, on the third part, are, as will be shown, very different.

Artificial anus may be divided into three varieties: 1. Congenital, 2. Accidental, and 3. Acquired.

1. To only one congenital condition may the present term be with propriety applied, to the condition, namely, where a Meckel's diverticulum opens at the umbilicus. This diverticulum, it may be remarked, is the remains of the vitelline duct, and in its most perfect condition it exists as a tube which extends between the navel and the ileum from one to three feet above the ileocæcal valve. This tube has a structure identical with that of the bowel from whence it springs. After the separation of the umbilical cord it is possible that it may open upon the surface and discharge fæcal matter. Such discharge is usually scanty and intermittent. It may persist for many years after birth. In most cases the opening, which is always small, will close spontaneously as the umbilical cicatrix contracts. Its closure may be aided by the application of the actual cautery, or, in instances where a somewhat larger aperture than usual exists, by a slight plastic operation.

2. In the accidental form of artificial anus the abnormal opening in the gut is brought about either by a wound, or by gangrene of the part, or by a perforating ulcer. If by a wound, then the damaged gut must have protruded at the orifice in the parietes at the time of the accident, must have become engaged in that wound, and ultimately have formed adhesions there. If, by means of a deep stab, a portion of the bowel—as, for example, the descending colon—is opened behind the peritoneum, so that that membrane is not damaged, the contents of the gut may be discharged upon the surface, but the condition would more usually lead to a fæcal fistula than to an artificial anus. In the same way gunshot wounds can only under rare circumstances lead to an artificial anus in the limited sense of that term, while they are frequently the cause of a fæcal fistula. Gangrene after strangulated hernia is a very common, and, indeed, the usual, cause of artificial anus. The gangrene may involve only a part of the convexity of the strangulated loop, or may implicate the whole of it, or the whole of the upper limb of the loop. Any form of ulcer of the intestine may lead to perforation. If the perforation takes place through a part of the bowel not covered by peritoneum, as at the posterior part of the descending colon, the intestinal contents find their way into the subserous tissue, an abscess is formed, and when that discharges itself through the skin, a fæcal fistula is formed, rather than an artificial anus. For this reason artificial anus can hardly result from ulceration having its seat in the colon, unless it be in the transverse colon. When such a form of abnormal opening has developed, as a result of intestinal ulcer, it will usually be found to have involved the small intestine. The ulcer, before it perforates, leads to some local peritonitis, by means of which the diseased loop becomes adherent to the parietes. By the time perforation occurs extravasation is prevented by the adjacent adhesions. An abscess follows, which in time breaks through the skin, and leads to an artificial anus.

3. In the acquired form the condition is the result of a colotomy or an enterotomy.

Anatomical condition.—There is, as a rule, only one opening in the skin, though in rare cases there may be more than one. The integument about the abnormal orifice is usually depressed, contracted, thickened, and excoriated. In cases of any standing it is continuous more or less directly with the mucous lining of the bowel. The gut—especially when it is a portion of small intestine—is much bent at the seat of the loss of substance. So great may be this bending that the segment of bowel below the anus may be parallel with that above it. As a result of this bending, a valvular fold appears on the wall of the bowel facing the aperture in the skin—on such part of the intestinal wall, indeed, as is left undestroyed. This fold is placed at the summit of the bend. Its extent depends upon the amount of intestine lost, and upon the acuteness of the angle formed in the bowel at the site of the artificial anus. It is more marked when the small intestine is involved than when the lesion is in the colon. It is perhaps most highly developed in cases that have resulted from gangrene. This valvelike fold or *éperon* is the chief cause of the permanency of the artificial anus, and the main obstacle in the way of spontaneous cure. It is often so extensive as to entirely cover over the opening in the bowel below the anus, and in any case acts as a conduit to direct the intestinal contents to the opening in the skin. The mesentery in the angle, which is always turned away from the surface, is found to be thickened, shrunken, and contracted, and takes a part in maintaining the permanency of the *éperon*. The bowel below the fistula is contracted, pale, and more or less empty, while the bowel above is often distended and not infrequently hypertrophied. The nature of the intestinal contents will obviously depend upon the part of intestine involved. The amount that escapes varies. All the fæces may be passed by the artificial anus in some cases, while in others there is but slight escape of fæcal matter, or only an occasional escape. The discharge from the fistula is influenced also by position, by the general health, and by the state of the bowels.

The skin about the abnormal opening may become the seat of much erythema or of erysipelas. The end of the bowel above the anus may become plugged or be occluded by acute bending, and symptoms of intestinal obstruction may follow. Much trouble — chiefly in the form of nausea, vomiting, and colic—may be occasioned by an accumulation of fæcal matter in the bowel below the artificial anus. The intestine may become prolapsed through the abnormal opening. This prolapse usually involves only the mucous membrane, but it may involve all the coats of the bowel. In the latter case it may be extensive and may even attain the length of one or two feet. As a rule the prolapse involves only one end of the bowel, and most frequently the upper end; it may, however, involve the lower end only. The prolapse may be reducible or irreducible. In certain cases a hernia has appeared at the seat of an artificial anus, the protrusion having been covered either by the thinned tissues about the anus, or by the wall of the bowel that is involved therein.

The *Prognosis* is unfavourable. When the anus involves the jejunum the patient, as a rule, soon dies of marasmus. When the middle ileum is implicated there is usually much wasting and malnutrition. When the lower ileum or colon is involved, the health need not become impaired by reason of the premature escape of the contents of the bowel. The condition usually involves much mental distress. In certain cases—more especially when the lesion has been due to hernia—spontaneous cure has followed at the end of weeks or months. Spontaneous cure, however, in the condition to which the special term artificial anus is applied, is quite rare.

Treatment.—The skin about the artificial anus must be protected as much as possible. It may be painted with collodion, but the collodion only obtains a very temporary hold of the integument. It may be kept constantly oiled with vaseline or with simple ointment. Attempts may be made by means of thin india-rubber tissue to conduct the escaping fæces away from the skin into a proper receptacle. The general health should be supported. If the fistula lie in the colon, the motions should be kept soft and constipation be carefully guarded against. Inordinate intestinal movements should be checked by opium. The diet must be cautiously selected, and be composed only of the most digestible materials. A suitable pad must be worn to receive the escaping fæces. Some are made for the purpose by instrument-makers, but as a rule the patient will construct some pad of his own which will suit the purpose better than a more elaborate receptacle. In any instance the most scrupulous cleanliness must be insisted upon. In slight cases spontaneous cure may be brought about by closing the abnormal aperture by pressure. This pressure may be effected by means of a truss or by a disc fixed over the fistula; or the edges of the anus may be approximated by strapping. In a recent case Mr. Banks effected a cure by inserting a piece of india-rubber tube into the two ends of the bowel. This brought elastic pressure to bear upon the *éperon*, while, at the same time, it maintained the passage of the intestine free.

The great obstacle to cure is the *éperon*. This has been kept thrust back by means of ivory plugs carefully fixed in the part, and attempts have been made to destroy it by the frequent application of caustics or the occasional use of the actual cautery. It must be confessed, however, that these various measures are of little avail. They possibly do no harm, but they certainly do little good. In any case of persistent artificial anus it is better to adopt a careful palliative treatment, to allow a reasonable time to elapse for the development of any evidences of spontaneous cure, and then to treat the condition by some radical means if it still remains without improvement.

These latter measures may be considered under three heads: 1. Denonvilliers' operation; 2. Dupuytren's operation; and, 3. Resection of intestine.

1. The operation of Denonvilliers is merely one of the many that have been proposed for the cure of this condition by what may be termed plastic measures. In the present procedure the mucous membrane is dissected up on either side of the artificial anus, its edges are freshened and then united by sutures. The integument is next dissected up, its edges are in like manner freshened and are approximated by sutures. This operation is of little value. It is well known that mucous surfaces are not readily induced to unite, and the barrier offered after the operation to the pressure within the bowel is very slender. The procedure, moreover, leaves the *éperon* untouched, and thus fails to attack what is probably the real cause of the persistence of the fistula.

2. In Dupuytren's operation the *éperon* is destroyed by inducing gangrene in it. This is effected by means of Dupuytren's enterotome. The enterotome is a strong pair of forceps with a male and female blade which can be freely and closely approximated by means of a screw. The *éperon* is taken up between the two blades, which are at once screwed together as tightly as possible. In from eight to ten days the *éperon* will have become ready to be separated, and the instrument may then either come away of itself, or—if it still holds on—may be removed. A free communication is thus established between the bowel above and below the abnormal opening, and a spontaneous cure commonly follows, the parts being left practically to themselves. In the reported cases such cure has followed the operation at a period varying from a few weeks to three or four months after the removal of the enterotome.

3. In this procedure the two ends of the intestine concerned in the artificial anus are resected, and the cut ends at once approximated by sutures by the first of the two methods described in the account of resection of the intestine. *See* Colectomy; Enterectomy. The edges of the openings in the integument are freshened and the parietal wound is closed after the sutured bowel has been reduced into the abdominal cavity. By this method the artificial anus can be readily and surely treated, and the success of the operation in the fistulous conditions which have followed strangulated hernia has been very encouraging. It is certainly a great advance upon the uncertain, tedious, and somewhat dangerous procedure of Dupuytren. The resection operation is by no means free from danger, but its risks are, in the writer's opinion, capable of being estimated and to a great extent guarded against. Frederick Treves.

ARTIFICIAL LIMBS, The Selection of.—The Lower Extremity.—The chief types of artificial limbs for this, are (1) the common pin or kneeling leg, (2) the bucket leg, (3) the bucket leg with a knee-joint, (4) the artificial leg proper, commonly described as the 'cork leg,' by those who are not aware that cork is no longer used in its construction.

The common pin or *kneeling leg* is made of wood (usually beech or ash for men, and willow for women). The socket is shaped like the letter U. The stem is a simple upright pin, pole, or stick, in fact the ordinary 'wooden leg.' A broad leather girdle surrounds the socket up to the middle of the thigh, a waist-band fixes the upper extremity of the outer branch of the U to the pelvis. This outer branch extends upwards much higher than the inner. The lower end of the pin is shod with leather, and sometimes provided with a spring. The weight of the body bears directly upon the bent knee as it lies in the fork of the U.

The bucket leg is a somewhat superior article to the pin leg. Its socket is bucket-shaped, and resembles an immense thimble inverted, and is made of willow wood and leather. The stem resembles that of the pin leg. When used for amputation of the thigh it is frequently made with a joint at the level of the knee, an obvious improvement.

The artificial leg proper. This is almost entirely made of willow; and the writer is told that the best wood grows on the banks of the Kennet, and is not easy to obtain. A certain amount of leather is used, especially in the upper parts. The joints are of wood, and the fastenings are of German silver with screws of plated steel. When used for a thigh amputation, an artificial limb contains joint mechanism for both the knee and the ankle. Sometimes this consists wholly of rubber bands; but the best makers usually dispense with these, and employ instead a strong spiral steel spring and a 'tendon' of the strongest catgut covered with leather. The spring passes down, inside the calf, from the knee to the heel, and when the knee is slightly bent pushes the heel down, at the same time lifting the toes. This is exactly what takes place when the artificial foot is carried forward in walking. On the other hand, the catgut 'tendon' (which lies side by side with the steel spring in the calf, but has a different attachment at the knee), comes into play when the knee is extended. It then drags on the heel, and holds the foot firmly down, so as to make it possible to stand on tiptoe by inclining the body forward a little. Thus the catgut tendon assists in the push off, and the steel spring tilts the foot up free of the ground, in the movement of walking. The mechanism just described is that of the well-known 'Anglesea leg.'

When the wearer sits down and bends the leg to a right angle, the steel spring is temporarily released from pressure at its upper end, and does not return into play until the knee is extended again about thirty or forty degrees. Braces of buckskin are used for both men and women, the former wearing them simply over the shoulders, the latter wearing also a waistbelt, to which the shoulder braces are attached in such a way as to leave the breasts free from pressure.

For a case of amputation below the knee with a long and good stump, it is sometimes unnecessary to take any bearings from the thigh. Artificial limbs, to take bearings from a bent knee (after the manner of the kneeling or pin-leg,) are sometimes made with a mere 'stop' knee-joint, and sometimes with a 'spring and tendon action knee-joint,' analogous to that described above.

For amputation below the knee in cases *where the bearings have to be taken from the thigh* as well as from the leg, artificial limbs cost as much as do those for thigh amputations. Artificial limbs for very high amputations of the thigh cost a few pounds extra according to the difficulties of the case.

Artificial limbs for *exarticulations at the hip*, whether done subperiosteally or otherwise, are for the most part useless, and are therefore dear at any price. The writer thinks, however, better results might be got by taking a firmer and more complete hold of the pelvis than is usually attempted, and is at present making some experiments in the matter.

For *Syme's*, *Pirogoff's*, *Chopart's*, and *Tripier's* amputations, the lost parts are replaced by new ones of light wood. As the bearings are directly on the stump itself, or on the heel in the last two cases, the artificial foot has merely to be fixed in position. This is usually done with a pair of steel rods, one on each side the leg, and a leather case, laced round the calf.

The kneeling or pin leg is not only excellent for permanent wear, when the amputation is in the upper third of the leg, but is often worn temporarily while the stump of a lower amputation, e.g. a Syme, is still tender and unfit to bear pressure.

When a Chopart is done in childhood, the limb does not grow as fast as its fellow. Consequently the instrument-maker must either fit on a high boot, or else apply a foot entirely artificial, attempting to conceal (not generally with much success) the knobby stump which now constitutes a kind of false and unsightly ankle. From an instrument-maker's point of view, Chopart's amputation should never be performed in childhood.

Lost toes ; Hey's amputation, &c.—The patient gets his boot-maker to pad the shoes in a suitable manner.

The stump-boot.—This is a cylinder of leather which grasps the calf, and is shod with leather like a boot. It is a cheap instrument for a case of Syme's amputation. It has no foot, but merely a circular sole of the same radius as the cylinder itself.

THE UPPER EXTREMITY.—Here again the materials are willow-wood and leather. But the hand and fingers are made of the wood of the lime tree. Proportionately, much more leather and less wood are used than in the case of the lower extremity.

Elbows are merely fitted with hinge-joints, unless a part of the forearm is left, when any power of pronation or supination should be carefully utilised. The elbow should be supplied with a little catch capable of fixing it at any angle.

The hand is fixed into the wrist by a metal socket and catch, and can easily be removed. The thumb contains a steel spring which opposes it to the fingers. The finger-joints are as a rule free from springs, but are purposely made to work passively with stiffness. But both thumb and fingers can be fitted with a grasping mechanism worked by either (1) the extension and flexion of the elbow, or (2) the pronation and supination of the forearm.

Sets of instruments are supplied (spoon, fork, knife, brush, hook, &c.), which screw into the palm of the hand, but have the appearance of being held by the thumb and fingers. But if a simple hook, with one or two instruments, such as a fork and spoon, be supplied instead of the hand, we get what is called a *bucket arm and hook*, much cheaper than 'an artificial arm,' by which is understood one with a hand. Not only table instruments, but trade instruments and tools, are made to screw into both artificial hands and bucket arms.

Artificial thumb and fingers.—When parts of the hand are lost, it is sometimes for the sake of appearance rather than for any other object that the mechanician should be applied to, except when a thumb is left without a finger to oppose to it, or *vice versâ*, or when both thumb and fingers are gone. In the former case especially excellent practical results can be obtained.

The cost of these appliances varies with the case, but is not usually much less than that of a new hand and forearm.

It has been already mentioned how useless all appliances are for most cases of amputation at the hip-joint. Artificial arms for amputation at the shoulder-joint are useful in an æsthetic rather than in a practical sense.

General remarks.—The various appliances in ordinary use in this country have thus been briefly described. Their merits have been tested by experience, and are not small. But an artificial limb of any kind, standing side by side as it usually does with its fellow, constructed by nature, does not, and never will, bear the comparison. Hence there are constant efforts to produce new forms of artificial limbs. It would be out of place to discuss here all these. Mention may be made of the artificial leg of Dr. Hermann, which will firmly support the weight of the body at whatever angle the knee may be bent, and the artificial limbs termed 'the Beaufort,' which occupy a position, as regards both appearance and price, midway between the complete artificial limbs described in this article and the mere bucket and pin legs.

General remarks on the choice of an appliance.—As a rule the simpler the appliance the more useful it is. This applies especially to the lower extremity. The direct contrary is generally believed by the ignorant. For example, a labourer wearing a bucket leg after a high thigh-amputation, does not get on very well. He longs for an expensive artificial limb with a knee-joint and foot. Nothing but experience will convince him that the latter will be even less useful. On the other hand a gentleman with a first-class artificial leg is often guided by common sense into getting for himself a simple 'bucket leg with knee-joint' to use for rough and active work.

It is extravagant and silly to supply growing children with elaborate artificial legs and feet. They require bucket legs, stump-boots, and the like, which can be frequently readjusted to their height, and are strong enough to stand playground usage.

Congenitally short arms and legs, if very short indeed, should be treated as mere stumps and fitted with artificial limbs. A clever instrument-maker will utilise every peculiarity of such a limb to increase its hold of and firm bearing on the appliance. Of course, if an arm has anything approaching to a useful hand attached to it, it is scarcely right to bury it in an artificial limb.

Measurements. — Space will not give room for elaborate details. Where possible, it is best to let the instrument-maker take his own measurements, or, when that cannot be done, to write to him for a paper of printed forms, diagrams, and directions. In remote regions attention to the following rules may suffice :—

(1). State whether a right or left limb is required.

(2). Give full measurements of the sound limb.

(3). State the exact spot where the amputation has been done (in inches.)

(4). Give a complete series of measurements of the stump.

(5). If the growth of one limb has not kept pace with that of the other side, indicate the exact position of each joint by measurements.

(6). Give tracings of the stump of the sound hand (or foot, as the case may be).

Casts are useful in the case of Chopart's amputation, or when a hand or fingers or thumb may be required. A tracing does for a Syme. A boot is useful.

The measurements of a sound leg should be taken with the knee extended. Of girths, there should be sent, one of the waist, two of the thigh, one of the knee, one between the knee and calf, one round the calf, one round the ankle, one between the last two. Send the exact height in inches of each girth measured. Send a shoe-maker's measurement of the foot, or else a shoe.

Of perpendicular heights, do not omit to send (1) the height from the fork to the ground ; (2) the height from the summit of the bent knee to the ground, and (3) from the middle of the calf to the ground.

Similar principles can be applied by any intelligent person to the upper extremity ; but it should be measured with the elbow bent.

C. B. KEETLEY.

ARTIFICIAL PUPIL. *See* IRIS, Diseases of the ; IRIDECTOMY.

ARTIFICIAL RESPIRATION. *See* SUSPENDED ANIMATION.

ASPHYXIA. *See* SUSPENDED ANIMATION.

ASPIRATION.—Before attempting to aspirate, it is necessary to thoroughly disinfect the needle, or trocar and canula, by means of the flame of a spirit lamp, or by some strong antiseptic agent. In using Dieulafoy's aspirator, the whole interior of the apparatus must be cleansed by allowing a quantity of strong carbolic solution (1 in 20) to pass through the tubes. Any defect in the taps or working of the syringe will then be detected. Great care must be taken, in using the finer needles, to push on in one direction only; and when using the aspirator for exploratory purposes, to establish the vacuum in the needle so soon as it has penetrated the skin and superficial structures. If, on pushing the needle as far as is thought judicious, no fluid be obtained, the needle must be withdrawn, and a fresh exploratory puncture made in another direction. The selection of the size of the needle or trocar to be used depends on the situation of the fluid and on its suspected character.

An advantage claimed for Dieulafoy's aspirator is that if the needle become choked it may be cleared by pushing down the piston, and driving some of the fluid back; but in using Potain's aspirator, the canula may be cleared, when necessary, by the careful introduction of a pilot trocar.

In acute abscess, aspiration rarely effects a cure, and is not advisable, but has been successfully employed in some acute cases of pelvic and abdominal suppuration. In some rapidly-forming pus collections, such as certain pyæmic abscesses, and in empyema in young children, aspiration may sometimes be employed with success.

Chronic abscess, unconnected with bone-disease, may occasionally be cured by one or more aspirations.

Large chronic abscesses in connection with disease of the spine, and of the hip, have been successfully treated by repeated aspirations. The indication for continued perseverance in this treatment is the increasing length of the interval between the successive accumulations in the cavity. In these bone abscesses, and especially in spinal abscess, unfortunately the pus generally rapidly re-collects after aspiration; and very often, owing to the amount of cheesy material in it, there is great difficulty in its evacuation. The largest trocar should be used, with antiseptic precautions, and care is necessary, in withdrawing the canula, not to leave any pus in its track, or a sinus is likely to be established. Aspiration must of course in all cases cease at once if blood should flow in any quantity.

Effusion into the pleural cavity is best evacuated by the aspirator. The operation is a little longer than tapping with special trocar and syphon tube, but there is less chance of the admission of air, and greater certainty of obtaining the fluid when negative tension exists. If the fluid be found to be purulent, it is generally best in adults to provide free drainage at once; but not infrequently in children, after one or two aspirations, there is no further secretion.

Pericardial effusion may be withdrawn safely by using a fine needle. The puncture should be made in the fourth or fifth interspace, about two inches from the left side of the sternum, and the needle must be passed upwards and inwards. To avoid penetrating the heart, it is important to obtain the vacuum in the needle so soon as the point is beneath the skin, and the needle should be held steadily during the flow of the fluid. *See* PARACENTESIS.

Hydatid cysts in the liver and other organs, when they contain clear fluid, will often shrivel up after aspiration; but relapse sometimes occurs after an apparent cure. A suppurating hydatid cyst, or an abscess of liver, may be explored by means of an aspirator, and their situation and depth from the surface determined; but for the treatment free drainage is necessary.

When there is a large collection of free fluid in the peritoneal cavity, a small syphon trocar is generally employed for its evacuation; but the aspirator is by far the safer instrument when the fluid is localised, or there is a doubt as to the diagnosis. For the exploration of any deep-seated collection of fluid in the abdominal cavity, only the finer needles should be used, and great care is necessary that intestine does not lie in front of the swelling at the seat of puncture.

A hydronephrosis may be aspirated at a point just below and anterior to the last rib; but the situation of puncture will vary according to the particular case.

Retention of urine may be relieved by the aspirator.

In aspirating joints, the interior of the joint must not be scratched with the needle or canula, and the limb must be kept at rest after the operation. The knee-joint not unfrequently requires aspiration for chronic effusion, or for distension with blood as a preliminary to the treatment of a fractured patella; and for the withdrawal of pus in certain pyæmic effusions, where the distension of the joint is sudden and unattended with signs of destructive changes. The aspirator or hypodermic syringe may also be employed for the purpose of diagnosis in doubtful effusions into a joint.

The aspirator has been recommended for the relief of gaseous distension of the bowel, and as a method of treatment in certain cases of strangulated hernia. It is, however, preferable to use a very fine trocar and canula, and to allow the air to escape without assistance by aspiration, which only tends to increase the chances of fæcal extravasation. The treatment of hernia by fine puncture has found little favour with English surgeons, and can only be very rarely advisable. Bernard Pitts.

ASPIRATOR.—This instrument was introduced into practice by Dieulafoy, in 1869, and with slight modifications the simplest form now in use is that designed by the inventor. It consists of a glass syringe, in which the nozzle has been replaced by a threeway tap. This tap places the cylinder of the aspirator in communication with two tubes, one connected with a hollow needle, and the other for carrying aspirated fluid away from the cylinder. It is so designed that the passage to either or both can be closed; in the latter case when the piston is withdrawn a vacuum is formed in the cylinder. If now the communication with the hollow needle is opened, the fluid in any cavity into which the needle has been inserted flows into the cylinder, and by turning the tap the communication with the needle is closed, and on depressing the piston the fluid obtained can be ejected, and the process repeated. The tubes are made of india-rubber, with coils of wire inside to prevent them from collapsing. The needles vary from $\frac{1}{50}$ to $\frac{1}{12}$ of an inch in diameter.

The advantage of using a hollow needle is that a vacuum can be produced in it as soon as the skin is penetrated, and it is then hardly possible to pass it without result through a collection of fluid.

Potain's Aspirator is a very useful one for ordinary practice. The apparatus consists of two parts—an exhausting syringe, and a glass bottle in which the vacuum can be produced. The apparatus is so fitted that any ordinary bottle with a narrow neck, and which will hold from two to three pints, can be employed. In the neck of the bottle is fitted a rubber plug, through which passes a metal tube with two branches, each of which is closed by a tap, while their extremities are fitted for receiving the conical metal ends of the india-rubber tubes which lead to the exhausting syringe and the hollow needle respectively. In place of the needle a trocar and canula can be used; but it is essential that the tube leading to the exhaust bottle should be attached at an angle to the canula, so as to permit of the trocar being withdrawn beyond the point of attachment of the tube without the possibility of admitting air into the canula.

In the aspirator just described, as the fluid does not come in contact with the syringe, the instrument is easily cleaned, and is not so likely to get out of working order as Dieulafoy's aspirator. With care in turning the taps, the bottle when full can be emptied, and again put in use, and large quantities of fluid be drawn off with little trouble or manipulation, the needle or canula remaining *in situ* during the process.

For exploratory purposes a small aspirator made on the same principle as Dieulafoy's may be employed, but a large-sized hypodermic syringe, with a long fine needle, is an excellent practical substitute. One loses, however, the advantage of the previous vacuum in the needle, and, consequently, fluid situated at an uncertain depth in a solid organ like the liver might be overlooked. Bernard Pitts.

ASTHENOPIA.—The term asthenopia signifies *weakness* of sight, as opposed to *dulness* of sight, or amblyopia, and is characterised by the patient having good vision so long as distant objects alone are regarded, and for a short time even when near objects are looked at, but in the latter case soon becoming fatigued and exhausted. It is usually regarded as presenting three forms, or perhaps, more correctly speaking, as attributable to three causes—weakness of the ciliary muscle, weakness of the internal recti-muscles and weakness of the retina. These are named respectively accommodative asthenopia, muscular asthenopia, and nervous asthenopia.

1. *Accommodative asthenopia.* This form is associated with hypermetropia (q. v.) In the hypermetropic eye the focus for parallel rays lies behind the retina, so that an effort of accommodation is required even to see distant objects distinctly; still greater of course must the effort be to see near objects from which proceed divergent rays. In moderate degrees of hypermetropia, and in young persons in whom the nervous power is considerable, the ciliary muscle active and the suspensory ligament and lens resilient, the effort can be maintained for a considerable period, even when minute objects are closely examined; but sooner or later the muscle becomes exhausted, and

then, if work is still persevered in, the muscle either passes into a state of cramp, known as spasm of the accommodation, or—which is far more common—the symptoms of accommodative asthenopia are experienced. These symptoms are that, after reading, writing, or paying attention to any near object for some time, a sensation of fatigue is experienced in the eyes. The letters of a word, or the lines on a page, or the stitches in work, become confused and run together, and though at first, by making a stronger effort, reading can still be continued, in the course of time, varying, with the degree of hypermetropia from a few minutes to an hour or more, everything becomes confused, and even moderately large print is illegible. Then the eyes become hot and feel full. The lids are swollen and congested. The secretion of the Meibomian glands being disordered, the edges of the lids become sore, and ciliary blepharitis is sometimes established. The conjunctiva is reddened. There is an increased flow of tears. The patient feels inclined to squeeze the lids together and to rub the eyes strongly with the fingers. He has often to rest them by looking away from the book or work, and finds relief in bathing them with cold water. Improvement is felt when books are put aside and open air exercise taken. In some the eyes are worst at night, especially if the type and the light are alike bad; but in others the vision is most dim in the morning, perhaps for the same reason that after a long and severe walk the muscular pain is greatest in the morning and wears off after gentle exercise. Muscæ and spots are often complained of. These are sometimes visible, and are doubtless particles of pigment detached from the ciliary processes or uvea by the rubbing and pressure of the eyes. Failure of the power of accommodation often makes itself felt during convalescence from some disease, when, owing to general weakness of the nervous system, the effort previously made without difficulty to overcome preexisting hypermetropia can no longer be made. The treatment of accommodative asthenopia must consist either in giving up all near work and leading an out-of-door life, or in the use of appropriate correcting glasses. The rules by which the selection of these should be undertaken are given in the article on hypermetropia. *See* Refraction, Errors of; Hypermetropia.

2. *Muscular asthenopia* is due to defective power or ‘insufficiency’ of the internal or external recti-muscles. On looking at a distant object the visual axes in a healthy person are parallel, but when near objects are regarded, not only is there an effort of accommodation, which is effected by the ciliary muscle, but the internal recti contract, and the visual axes are made to converge. If either of the internal recti are weak, an unusually strong nervous impulse has to be generated by the nerve-centre to maintain the contraction of the muscle, and fatigue, soon amounting to pain, is experienced. After a little while the effort can no longer be sustained, and then the eye rolls outwards, under the influence of the opposite rectus, and diplopia results. In some cases the effort is so trying that severe headache and even vomiting may be induced when close work is compulsory, whilst in others chronic conjunctivitis may be established, with frequent attacks of phlyctenular ophthalmia. The insufficiency of the rectus internus can easily be ascertained by a simple experiment. A thick black line three or four inches long should be ruled vertically in the middle of a sheet of paper, and in the centre of the line a spot or short cross-bar made. A prism of 10° or 12° should now be held with the base downwards before one eye. If the recti are in a normal condition, and the sheet be held at a distance of about six feet, two images of the spot will be seen, one exactly above the other, but only one of the line through this will appear prolonged. If, however, there is insufficiency of one muscle two lines as well as two spots will be seen, and the image seen by the eye before which the prism is placed will be higher than the other, and crossed or shifted to the opposite side. The reason of its occupying this position is, that the prism throws the image upon a lower part of the retina, and, in accordance with the law of projection, it appears to be higher, whilst the weak internal rectus muscle being no longer compelled to contract in order to effect the fusion of the two images, gradually yields to the external rectus, and the eye rolls or deviates outwards and, again in accordance with the law of projection, gives a crossed double image, so that if the right internal rectus is insufficient, the image is on the left side, and *vice versâ*.

The degree of insufficiency may be approximately ascertained by a simple proceeding, for by still keeping the prism with its base downwards before the eye, it is only necessary to place a succession of prisms with their bases inwards before this eye until one be found which causes the two images to be superimposed—that is, to give two spots but only one line—and the amount of insufficiency is at once determined. Unfortunately, in many instances the position of rest or equilibrium is not immediately assumed by the eye at fault, a strong nervous impulse being still directed to the muscle even when the images are separated by the first prism, and hence the amount of latent divergence is often considerably under-estimated. The treatment of muscular asthenopia must consist in the employment of appropriate prismatic glasses, superadded to those that are requisite to correct any other error of refraction, such as myopia, astigmatism, &c., with which insufficiency of the internal rectus is often associated. *See* Strabismus; Ocular Muscles, Affections of the.

3. *Nervous Asthenopia.*—This form of asthenopia appears to be associated with general depression of the nervous system, and is then due to the circumstance that the patient, whilst possessing perfectly normal vision, cannot, without great distress, bring the ciliary muscle into action. As soon as a book is taken up or sewing commenced, the mere effort of accommodation, which in health can be easily and long sustained, occasions an insupportable feeling of fatigue, and it is quickly put aside. Such a condition may not infrequently be seen in women recovering from their confinement, in children suffering from spinal disease or convalescent from measles, scarlet fever, or diphtheria, in those who have suffered from hæmorrhage; and the writer has repeatedly observed it in riveters and fitters in Chatham Dockyard after contusions of the eye, to which they are particularly exposed. It may also be noticed as a symptom in the early stage of sympathetic ophthalmia. In these, as well as in the former class of cases, the powers of the retina appear to fail, a dark spot or scotoma quavers before the eye, confusing, or altogether obliterating, the outline of any object that is attentively regarded, and a contraction of the field of vision may sometimes be noticed. The retina seems, in some instances, to be hyperæsthetic, so that bright lights, especially when they flicker or vary in intensity, annoy and distress the patient. The most careful examination of the eye by means of the ophthalmoscope often fails to discover any abnormal condition (*see* Accommodation, Disorders of). The treatment should be both local and general, the local treatment consisting in directing the patient to desist from all work requiring close attention, and, where intolerance of light is a prominent symptom, the protection of the eyes with smoked, blue, or green glasses. The general treatment must, of course, depend on the conditions of the system to which the asthenopia may be referable. The best remedies are strychnia—which may either be injected in doses of one-twenty-fifth up to one-tenth of a grain every day, or may be taken in the form of tincture of nux vomica, in doses of ten to twenty minims—and such tonics as quinine, iron, arsenic, and sulphate of zinc. As a rule, such cases ultimately, though often but slowly, recover.

Henry Power.

ASTIGMATISM.—A condition of the eye in which entering rays are unequally refracted in different meridians, such rays being consequently never focussed to a point, as in the ordinary eye. *See* Refraction, Errors of.

ASTRAGALUS, Dislocations of the.—The astragalus may (1), whilst retaining its relations to the tarsal bones, be dislocated from the tibia and fibula. These tibio-tarsal dislocations are described as dislocations of the Ankle-Joint. (2) Whilst preserving its relations to the tibia and fibula, it may be dislocated from the bones of the foot; these dislocations are described as Sub-Astragaloid. (3) It may be separated from its normal attachments both to the tibia and fibula and to the bones of the tarsus, and be displaced alone. These proper dislocations of the astragalus will be here described.

The proper dislocations, or enucleations, of the astragalus are usually described as four in number, viz.: *forwards*, *backwards*, *inwards*, and *outwards*. But the forward dislocation includes displacement in three directions, viz. *forwards and upwards*, so that the head rests above the scaphoid and cuneiform bones; *forwards*, *upwards*, *and outwards*, when the head rests on the cuboid; and *forwards*, *upwards*, *and inwards*, when the head rests above and internal to the scaphoid. So also the backward dislocation includes dislocations *directly backwards*, and dislocations *backwards and outwards*, and *backwards and inwards*. Besides the direction of its displacement, the dislocated bone may be found rotated on a vertical or on an antero-posterior axis. For these rotations, Barwell suggests respectively the terms 'version' and 'torsion.' It has even happened that the bone has been turned completely over, so that the under surface looked upwards.

The forward dislocations are caused by over-extension of the foot. The ligaments attached to the astragalus are thus torn through, and the tibia, gliding down on its posterior surface, forces the bone out of its bed. Rognette, experimenting on the dead subject, found that he was only able to produce a forward dislocation, and he therefore concluded that the others were produced secondarily.

Symptoms.—The sign by which the injury may be recognised is the presence of an abnormal bony prominence projecting boldly beneath the skin in front of the ankle. The rounded head of the astragalus will be recognised at the anterior part of the prominence, and behind this will be felt the trochlear surface. The presence of the latter is of importance, and sufficient to distinguish this injury from subastragaloid dislocation of the foot, which has often been confused with it. When complete, the height of the foot is diminished, owing to the tibia settling down upon the os calcis, and the malleoli are brought nearer to the ground. At the same time the motions of the ankle are lost. When the bone is inclined outwards the foot is somewhat inverted, and when inwards the foot is everted.

To reduce this dislocation the patient's leg should be flexed to a right angle with his thigh, to relax the gastrocnemius; one assistant should then fix the knee, whilst a second, seizing the heel with one hand and the instep with the other, makes extension on the foot. The surgeon then, by pressing on the astragalus with his thumbs, may succeed in replacing it. Should extension and manipulation fail to reduce the bone, the tendo Achillis should be divided, by which means the soleus is paralysed. Any other tense tendons—the peronei, anterior tendons, or tibial—may also be divided, to aid in reduction.

All attempts to reduce the bone having failed, the foot may be secured on a splint and left covered by an icebag till the swelling has subsided. A fairly useful limb may in this way be obtained. More commonly, however, the skin sloughs over the bone and necessitates secondary excision. The statistics at present are in favour of secondary rather than primary excision, but if the case were treated from the first antiseptically, it is probable that these statistics would be modified or reversed. The writer would throw it out as a suggestion that, under these favouring circumstances, a free exploration might be made and all opposing bands divided till the astragalus could be replaced. There is no good reason for supposing that, because it was temporarily detached from its connections, it must therefore of necessity become necrosed, and the experience of simple complete dislocations favours the view that it would recover.

Dislocation backwards is caused by over-flexion of the foot on the leg. The ligaments are in this way torn, and the tibia, descending upon the neck of the astragalus, forces the bone into the space beneath the tendo Achillis. The bone may be found lying directly beneath the Achilles tendon, or it may be deflected to one or the other side; hence we have dislocations directly backwards, backwards and outwards, and backwards and inwards. If forced directly backwards without rotation or version the tendo Achillis may be pressed upon, as happened in a case described by Phillips, where this tendon was made 'to describe an angle of 40 degrees.' At the same time that the projection behind is noticed, a deep hollow can be felt with the finger immediately in front of the ankle, whence the bone has been displaced. Another symptom that has been noticed is extreme flexion of the great toe, which is readily accounted for when the position of the groove for the flexor longus pollicis on the back of the astragalus is remembered. The malleoli descend, and the foot has sometimes presented an appearance of slight shortening, but it is neither inverted nor everted. It should be remembered that, owing to the hollow in front of the tendo Achillis being liable to be filled up with blood-effusions after injuries to the ankle, the backward dislocation may be overlooked, and this occurred in a case related by Boyer, and in another described by Fergusson.

To reduce this dislocation, the leg should be first flexed on the thigh, then, extension being made on the instep and heel and counter-extension at the knee, the surgeon should endeavour to press the bone forwards into its place. At first the foot should be strongly flexed, and when the bone has been engaged in the gap between the tibia and os calcis, the foot should be gradually brought down to a right angle, at the same time that forward pressure is still exerted on the astragalus. Of eight recorded cases only one was reduced, and in this case both malleoli were fractured, but the patients have recovered with useful feet. Owing to the space into which the dislocation takes place, there is less stretching of skin and less necessity for excision in this than in other dislocations of the bone. If compound, it is probably the best practice to excise immediately attempts at reduction have failed.

The lateral dislocations of the astragalus are almost invariably compound, and usually associated with fracture of one or both malleoli.

In *dislocation inwards* the bone escapes below the tendon of the tibialis posticus. The bone is seen protruding beneath the inner malleolus, and is often rotated on an antero-posterior axis. This torsion of the astragalus, so frequently noticed, appears to be caused by the pressure of the opposite malleolus, whilst the tendon of the flexor longus pollicis behind probably determines the axis of rotation. As might be expected in this dislocation, the posterior tibial artery is sometimes ruptured and the accompanying nerve lacerated.

In *dislocation outwards*, the bone protrudes immediately beneath the outer malleolus, and above the tendons of the peroneus longus and brevis. The outer and inner malleoli are almost always fractured, but in a few instances they have both escaped. The foot is bent inwards, and the bone protrudes between the malleolus and os calcis.

In the treatment of the compound dislocations of the astragalus, inasmuch as the violence producing them is great, the question of amputation will have first to be decided. This will be determined by the amount of damage to the soft parts, the injury to vessels, exposure of tendons, and comminution of bones. Having decided against amputation, the surgeon will probably attempt, by extension and manipulation, to reduce the bone. Should he fail in this, there still remain two courses open to him. He may saw off the projecting head, and then again endeavour to effect reduction, or he may proceed at once to excise the whole bone. Even rupture of the posterior tibial artery and laceration of its accompanying nerve (though injuries adding much to the responsibility of an attempt to save the foot) should not alone frame the surgeon's resolution in favour of amputation, for in a case of this kind related by Astley Cooper, the bone was excised and recovery took place.

R. CLEMENT LUCAS.

ATHEROMA. *See* ARTERIES, Diseases of.

ATLANTO-AXIAL DISEASE. *See* CARIES OF THE SPINE.

ATLAS, Fracture and Dislocation of the. *See* BACK AND SPINE, Injuries of the.

ATRESIA ANI (Imperforate Anus). A congenital condition from arrest of development at an early period of intra-uterine life, resulting in an absence of the normal communication between the surface of the body and the interior of the lower end of the alimentary canal. This canal is, at the fourth week of intra-uterine life, a tube, closed at both extremities, and opening anteriorly at its lower part into the sac of the allantois, of which the intra-abdominal part subsequently becomes by development the bladder and urachus. About this time a depression is formed on the surface of the embryo at the site of the future anus, and by the upward extension of this the anal channel is developed, the upper end of which is in close proximity to the lower end of the bowel. By absorption of the intervening tissues the normal opening is established. At the same time a separation is being formed between the rectum and the bladder. This is usually completed by the tenth week of fœtal life. During the next few weeks, the growth of the perineum separates the urethra in the male, and the genital tract in the female, from the rectum. But this process of development may be arrested in any stage and in varying degrees.

Sometimes at birth the anus is almost or altogether absent. This constitutes atresia ani. In other cases the anus is well-formed, but is separated from the bowel by a thin membranous septum, constituting atresia recti. In other cases the rectum may have been badly developed, so that the bowel may cease at the level of the promontory of the sacrum or even higher. Again, imperforation of the bowel may be complicated by the persistence of a communication between the rectum and the bladder or urethra in the male, or the genital tract in the female; or, more rarely, there may be abnormal fistulous openings on the back and abdomen. Another rare form of atresia ani results, not from mal-development, but from adhesion of the epithelial surface of the anal passage. The diagnosis of these cases cannot cause any difficulty. If the anus be absent the defect must be at once apparent. But if there be an anus, and an obstruction higher up, the absence of any alvine discharge and the vomiting which will speedily supervene, together with distension of the abdominal parietes, will indicate the nature of the case, of which assurance can be obtained by the introduction of a blunt probe into the anal passage. The discharge of meconium by the urethra, vagina, or fistulæ elsewhere, will demonstrate the additional complications.

Treatment.—If atresia ani be due merely to epithelial adhesions, traction from the median line on both sides of the perineum will suffice to separate them, and re-adhesion may be prevented by the occasional introduction for a few days of a pledget of oiled lint. If there be a membranous septum between the anus and the rectum this will usually bulge downwards in the straining efforts of the infant to defecate, and a linear or crucial incision, with possibly excision of a part of the membrane, will give the requisite relief. If the septum be higher up, then division of the posterior wall of the anal passage may be requisite to bring it into view. If the anus be absent, or if a considerable thickness of tissues intervene between it and the rectum, a more troublesome operation will be requisite. The child should be placed in lithotomy position with the buttocks well raised, and, the bladder having been emptied by a catheter, an incision should be made in the median line backwards from the margin of the anus, if present, or from the normal situation thereof, if absent, and the dissection carried upwards in this plane, if necessary, along the concavity of the coccyx. If by this dissection the lower end of the bowel can be exposed, two sutures should be passed, first through one margin of the skin-wound, then across the bowel, and next through the other margin of the skin. The bowel should then be incised, the loops of suture drawn down and divided, and the bowel thus secured by four sutures to the skin. If this dissection should fail to expose the bowel, firm pressure should be made on the abdomen; and if this convey to the finger of the operator pressed into the perineal wound a distinct sensation of bulging, so as to indicate the near proximity of the bowel, the cartilaginous portion of the coccyx may be removed, so as to give more room, and the dissection continued a little higher. If the bowel can be thus brought into view, an attempt should be made, as before, to secure it to the skin, as otherwise a stricture will be inevitable.

But if this prove impossible, the bowel must be incised *in situ*, and the surgeon must endeavour, by the introduction from time to time of laminaria bougies, to keep the passage patent. If abdominal pressure, however, give no satisfactory indication of the proximity of the bowel, it is better to cease from any further perineal exploration, and to make an artificial anus. This may be done by Amussat's operation in the left loin, or by Littre's operation in the left groin. Amussat's operation is by no means easily performed on the infant, from the limited space in which the surgeon has to operate, and the difficulty of maintaining cleanliness with an artificial anus in this position is much greater in the infant than in the adult. Littre's operation is free from both of these objections, and may be performed as follows:—An incision, an inch in length, should be made in the abdominal wall, commencing a finger's breadth internal to and on a level with the left anterior superior spinous process of the ilium, and extending downward parallel with Poupart's ligament. The skin, fasciæ, and aponeurosis of the external oblique muscle having been divided, the fibres of the internal oblique muscle must next be carefully scratched through, as a muscular branch of the deep circumflex iliac artery always passes at this place between the internal oblique and transversalis abdominis muscles. The transversalis muscle and fascia must next be divided, when the sigmoid flexure may, if distended with meconium, as is usually the case, bulge into the wound.

If, from intra-uterine peritonitis, the peritoneal surfaces are adherent, this cavity will not be opened, and the projecting bowel should be at once attached to the skin wound by half-a-dozen sutures; but if the bowel is not distended, or if it is empty and collapsed, as may happen when the operation has been postponed for some days, and there has been persistent vomiting, the peritoneum must be divided and the bowel, if requisite, drawn forward and secured as before, care being taken to include in the sutures the divided edges of the parietal peritoneum. A linear incision of about half-an-inch in length should then be made in the bowel, and the edges secured by sutures to the skin wound. Starch-powder will protect the skin from irritation, and a pad of tenax may be used to receive the fæces. In some cases the sigmoid flexure is so distended as to lie in the right iliac fossa; but statistics of cases that have been examined after death prove that this does not occur so frequently as to justify operating on the right side in the first instance, when the probability of opening the cæcum will be very great.

If there be a recto-vesical or urethral communication, and if it be impossible to effect an opening from the perinæum, Littre's operation should be performed, to divert the course of the fæces and allow of the possible closure of the abnormal channel. Subsequently, by the introduction of a probe through the artificial anus, the course and extent of the bowel may be explored with the view, if possible, of making an opening in the perineum.

If there be a recto-vaginal or uterine communication the child will not be in any immediate danger, provided that the aperture be large enough to admit of a free discharge of fæces; but as such a channel has a natural tendency to close, an attempt should always be made to establish an opening in the normal region. If this fail, and the abnormal passage diminish so as to cause obstruction, it may, if accessible, be dilated, or Littre's operation be performed.

No rule can be laid down as to the treatment of fistulæ in other parts of the body. They are very rare, and each case must be decided on its merits.

The prognosis will depend on the condition of the child and the nature of the obstruction. If the child be otherwise well developed, and the obstruction be due to epithelial adhesion or a membranous septum, the result of treatment will probably be good. This is true also of cases where dissection is requisite to expose the bowel, if this can be attached to the skin. When this is impossible, the passage of fæces over a raw surface, and the necessarily frequent introduction of dilators, will greatly diminish the chance of a successful result. Cases have been recorded of infants, on whom the operation for artificial anus has been performed, having lived to adult age. But these cases are few in number, and, according to the writer's experience of hospital patients, the infants have usually died within three months.

Jeremiah McCarthy.

ATROPHY.—Atrophy, when the result of simple senile decay, is of importance mainly as providing an index to the declining functional and nutritive activity of organs and tissues, and thus furnishing the surgeon with the knowledge that structures so affected are liable to suffer in unusual degree from the immediate and remote consequences of injury and disease. The wasting incidental to age may involve most or all of the tissues, but it is often concentrated on one or a few, notably the vascular system, the muscles, and the bones. In the arteries, fatty atrophy of the constituent elements is commonly associated with fibroid substitution and irregularly disposed calcification. From these combined changes the walls of the vessels lose their resiliency and contractility, and the calibre of the small and medium-sized arteries—in which the blood-pressure is not sufficient to cause dilatation—is diminished. The vasa vasorum, too, are implicated in the process, and not seldom their lumen is obliterated. The above-mentioned conditions constitute the chief anatomical factors of continued primary bleeding following wounds, of late recurrent hæmorrhage after ligature, and of dry gangrene. Fatty metamorphosis of the heart, and of the cornea (arcus senilis) is a frequent concomitant of arterial degeneration. *See* Arteries, Diseases of.

In the fragilitas ossium of old people, the rind of compact tissue is attenuated, and the cancellous structure rarefied, whilst the spaces are filled with fat. An example may be seen in the neck of the femur, which is shortened and set at a more acute angle with the shaft—circumstances which favour the occurrence of intracapsular fracture from slight and indirect violence.

Another familiar instance of senile atrophy of bone is seen in the edentulous lower jaw.

In a few instances atrophy takes place apart from obvious degenerative change in the tissue-elements—e.g. as the glandular acini of the breast shrink on the cessation of lactation, the epithelial cells which line them simply waste away without their protoplasm being converted into molecules of fat; and again, as the contents of the fat-cells disappear in starvation they are often replaced by a clear fluid, which gives rise to a serous œdema of the cellular tissue, a condition well-known to pathologists as co-existing with emaciation, but the process is one of infiltration and not true metamorphosis. In the majority of cases, however, *the mode of atrophy* is apparent, being effected or accompanied by one or more of the various forms of degeneration. Thus, in the development of arcus senilis, and in senile rarefaction of bone, the connective tissue cells are converted into fat, and in inflammatory disintegration both fat and mucoid material are found in abundance, as may easily be seen in caries. Lastly, as nutrition fails in the arteries, and in the rib-cartilages, the parts become petrified with lime-salts; calcification, in short, when it occurs, is the final stage, and its result the abiding mark of the spoiling of tissues.

Atrophy of an organ is always accompanied by a proportionate loss of function. The bulk is at the same time usually, but not invariably, diminished. A bone may be so fragile as to break on the application of very slight force (spontaneous fracture) and yet it may retain its normal size. This is known as eccentric atrophy. More rarely there is actual enlargement of the part in spite of the atrophy of its special histological elements; thus, whilst the muscles of the calf are fast losing their contractile fibres, fat may be infiltrated into the cells of the interstitial tissue in quantity more than sufficient to make up the deficiency. Fatty substitution attains its maximum in these cases of pseudo-hypertrophic paralysis. Atrophy is termed *essential* when it happens without any assignable local cause—e.g. fatty degeneration of the corneal corpuscles, and of the endothelial lining of arteries. It is called *secondary* when due to some manifest means of disturbance of nutrition either by direct interference with the circulation, or indirectly through partial or total abrogation of function. Atrophies from continuous pressure come under the former category, those arising from disuse of a part under the latter.

CAUSES AND VARIETIES OF ATROPHY.—(1) *Physiological Atrophy* — 'Development and growth, maintenance and repair, decline and death, together with the discharge of function, make up the sum total of the life-history of all the tissues.' After parturition the *uterus* undergoes involution, or reversion to its quiescent state, from atrophy of its muscular fibre-cells, many of which are removed by absorption subsequent to molecular disintegration. At a certain epoch the *thymus* gland is subject to atrophy. Later on a similar fate awaits the *thyroid body*, in which colloid degeneration of the epithelial cells within the acini is a conspicuous feature. It is an interesting fact that the normal retrograde metamorphosis is not unfrequently disturbed, disorderly hypertrophy masking the intrinsic atrophy, so that instead of the bulk of the organ being lessened it is increased. Senile atrophy stands, as it were, on the frontiers of health and disease. In its incidence it is physiological, in its progress it becomes pathological; partly by reason of other changes being linked with it, and partly because the various systems and organs are not affected in like degree nor even simultaneously, there is a disturbance of the metabolic equilibrium of the tissues.

(2) *Atrophy from Diminished Function* is exemplified in the wasting of paralysed limbs; in the shrinking of muscles and the partial absorption of bones concerned in an unreduced dislocation; and in the loss of substance which gradually ensues in a stump after amputation.

(3) *Atrophies of Nervous Origin.*—There can be no doubt that when the innervation of a part is disorderly or absent, certain errors of nutrition are liable to supervene, and amongst them is atrophy. In no other case is it more manifest than when a nerve-trunk is severed. The distal portion dwindles away, as the white substance of Schwann is removed by absorption. Meanwhile the consistence of the nerve is sensibly diminished, so that in the operation for effecting union of the segments the difficulty of retaining them in apposition, under tension, increases in proportion to the length of the interval that elapses between the infliction of the injury and the attempt to repair it. *See* NERVES, Injuries of.

One of the most prominent features of Charcot's disease of the joints is the erosion of the articular surfaces of the bones; the head and neck of the femur, for instance, have been found absent. By some pathologists it is contended that the atrophy is entirely owing to excessive friction, or in other words that the influence of the nervous system is merely permissive, the normal check upon movement of a diseased joint being annulled, owing to the analgesia of the limb. The balance of evidence, however, seems to be in favour of the hypothesis which supposes the wasting to be in some measure directly due to perverted function of the nerves. *See* CHARCOT'S DISEASE.

The degree of atrophy of the muscles in caries of joints varies within considerable limits. In cases where the pain is severe and lasting it is often surprisingly marked, both as regards extent and rapidity; not that the atrophy is so much the immediate consequence of the pain, as that the latter is the indication of active disturbance of normal innervation.

(4) *Atrophy from Partial Deprivation of Blood-supply.*—There are several ways in which this result is worked out:—(*a*) The nutrient artery of a long bone may be compressed by a tumour or torn through in fracture; (*b*) or the obstruction may be on the venous side of the circulation, the proper renewal of arterial blood being prevented; wasting of the testicle from varicocele, and of the liver-cells in portal and systemic venous congestion, are apposite examples. Under such conditions an ill-developed form of fibrous tissue supplants the more highly specialised elements, and, contracting, strangles the smaller vessels—an additional source of atrophy. (*c*) In atrophy of the hard palate from a badly-fitting obturator, and of the kidney from impaction of a calculus in the ureter, the pressure is diffused and acts alike on arteries, veins, and capillaries. Cornil and Ranvier have shown that there is something

more than simple absorption from starvation, for the tension on the tissues sets up inflammation, which is rarefying in the more exposed parts, whilst it is condensing in the deeper. Thus after maceration of vertebræ excavated by an aneurism, the eroded bone is seen to be closer in texture than normal cancellous tissue. AUGUSTUS J. PEPPER.

AUDITORY NERVE. *See* EAR, INTERNAL, Diseases of the.

AURAL EXOSTOSES.—Aural exostoses of the nature of spongy osteomata are the most frequent form of bony tumour in the ear, and are definable by the following characteristics:—They are usually pedunculate, may be somewhat movable, occur singly, and at any point in the meatus, very rarely in the tympanum, but commonly at the junction of the cartilaginous and osseous portions; are of rapid growth, and are associated with suppuration; may be preceded by polypus, and are often developed, by ossific growth, from polypoid granulations; and can be removed by simple operative measures. On microscopic section they show a structure similar to that of newly formed bone, with the free surface bounded by a finely papillate fibrous membrane coated with squamous epithelium, and the osseous trabeculæ constituting a framework for a vascular medullary tissue, containing, in the most internal portions, spindle in addition to round cells.

Other growths, of compact but not ivory-like consistency, constitute the majority of the multiple exostoses. Microscopically they resemble syphilitic nodes of the cranial flat bones. Within their epithelial and fibrous investment are seen, at right angles to the surface, somewhat irregular Haversian canals of periosteal origin, containing blood-vessels; these canals are fewest in the more compact, slow-growing tumours.

Ivory aural exostoses, or, rather, hyperostoses, occur in the form of a ridge-like protuberance, or as one or more rounded broad-based tumours, usually on the posterior wall and near the orifice of the external meatus, are neither of congenital nor of active inflammatory origin, are of slow growth, and are commonly met with in both ears. They are more frequent in the male than in the female sex. Externally they are covered with a smooth, hairless insensitive cutis. Of extreme hardness, they present microscopically the characters of excessively dense bone. The external squamous and fibrous coating is thin, and contains few and small vessels. The bony lamella, between which lie lacunæ with blood-corpuscles, do not follow the course of the vessels, but run parallel to the surface, at right angles to which usually pass the canaliculi. Vessels are perceptible, as a rule, only where at its base the tumour becomes continuous with the temporal bone.

Etiology of aural exostoses.—Assigned causes for aural exostoses in various cases are partial hyperplasiæ during the stages of development of the osseous meatus, occurring in the form of small symmetrical, comparatively innocent, bilateral osteomata (Politzer); circumscribed and diffuse inflammation of the external meatus; heredity, which, or else mechanical irritation, may account for the frequency of aural exostosis among the aborigines of America, as evidenced by their skulls; and syphilis, gout, and rheumatism. In nearly all instances of double ivory exostosis, mechanical irritation due to habitual sea-bathing seems to have been the initial cause.

Rate of Growth.—The compact aural exostoses are the most slowly formed; and the spongy osteomata, as one might infer from their larger vascular supply, are of comparatively rapid growth. It would be somewhat difficult to arrive at an approximate estimate of the rate of development of the ivory exostoses, as their existence in the ear is commonly overlooked until they cause uneasiness by pressure on the meatus, and interfere with audition.

Treatment.— For the removal of exostoses the gouge or, in the case of pedunculate growths near the orifice of the outer ear, the gouge and mallet have been recommended. The galvanic cautery, the chain-saw or écraseur, the trephine used in places for the induction of caries, polypus snares, and dentist's forceps, have all, with more or less success, been resorted to. Bonnafont's method of establishing the patency of the meatus by the introduction of a plug between its wall and the contained tumour is barely practicable, according to the writer's experience, on account of the intense pain it gives. Von Tröltsch's prolonged dilatation with laminaria tents seems scarcely more satisfactory as a radical mode of dealing with the obstruction to hearing caused by an exostosis. The use of a dentist's drilling machine, first suggested by Dr. Matthewson, of New York, for the channelling of the very hardest ivory exostoses, has been found productive of eminently good results.

For the ready and safe performance of the operation, however, there are several requisites, namely, a couch for the patient sufficiently high to permit of the proper application of the drill, a steel guard to fit round the exostosis and to protect adjacent parts, drills of various sizes and shapes for the gradual enlargement of the opening to be made, and assistants to work the treadle of the machine, to administer an anæsthetic, to hold the steel guard in position, and to sponge or syringe-out blood effused in the meatus. It is highly important to begin the drilling operation close to the guard, as thereby the exact direction in which to work is ascertained, and always to proceed with both slowness and caution. The subsequent treatment of the patient resolves itself, usually, into combating, if necessary, the effects of secondary inflammation. Granulations in the meatus sometimes retard recovery. For these tannic acid is a useful astringent; and Dr. Victor Bremer, of Copenhagen, recommends the application of pin-shaped pieces of *Laminaria digitata.*

In the case of multiple exostoses, drilling is usually unnecessary, as, in consequence of mutual pressure and interference with growth, these usually leave a passage in the meatus sufficient for the transmission of sound: this, if blocked with cerumen or a polypus, is not cleared without difficulty. By the use of bone-forceps, which may be preceded by drilling, aural exostoses, other than the ivory-like growths, may in many instances be very readily removed. In one case operated on by the writer, a dentist's elevator served to sever the tumour from its base.

The possible importance of prompt perforation or removal of an aural exostosis has been illustrated by several examples of death, owing to the imprisonment of discharges through stenosis of the meatus. Obviously an operation for the removal of exostosis is indicated in all cases of otherwise irremediable deprivation of hearing.

G. P. Field.

AURICLE. *See* Ear, External, Diseases of the.

AXILLA.–The deep and roomy axillary cavity is one of considerable surgical importance, as it transmits the large blood-vessels and nerves of the upper extremity and contains numerous glands in connection with the lymph-ducts of this limb, and of the walls of the chest and abdomen. These structures are packed in a mass of lax connective and adipose tissue, which may be readily infiltrated by a large quantity of effused blood or inflammatory exudation, and offers but slight resistance to the expansion of any rapidly growing tumour. The anterior or pectoral wall, with its broad level surface, is formed in great part by the pectoralis major. Along the well-marked inferior border of this wall, or just behind it, are situated some lymph-glands, which are usually the first to become infiltrated in cases of cancer of the breast; and at its upper and outer limit is the interspace between the pectoralis major and deltoid muscles, which may be obliterated by effusion within the capsule of the shoulder-joint, and through which the pus of a deep axillary abscess sometimes comes to the surface. Near the unyielding inner wall, formed by the first four ribs and the serratus magnus and intercostal muscles, will be found the nerve of Bell and a chain of deep-seated glands, which receive lymph-vessels from the breast and the front of the chest, and of the abdomen above the level of the umbilicus. At the outer part of the cavity, bounded by the upper extremity of the humerus and the coraco-brachialis muscle, is the large vasculo-nervous cord formed by the axillary artery with its vein and the nerves of the brachial plexus. Here is another set of glands which are liable to become enlarged in cases of inflammatory irritation or specific inoculation on any part of the surface of the upper extremity.

The back of the cavity is securely closed by the scapula and the subscapularis and other muscles; and here, in connection with the subscapular artery is a third set of glands, which are connected with the lymphatics of the back of the chest. Through the open apex of the axilla, bounded by the clavicle, the scapula, and the first rib, which transmits the large vessels and nerves from the neck to the upper limb, blood, pus, and other inflammatory effusions, and even rapidly growing and infiltrating tumours, may spread from one region to the other. The large quadrangular base of the cavity is covered by thin, soft, and very sensitive skin, studded by long fine hairs, and abundantly supplied with sebaceous and sweat-glands. As a result of its situation and structure this portion of the general integument is a frequent seat of boils, of small superficial abscess, and of inflammatory eruptions due to direct irritation.

The chief point of interest in connection with the deep fascia of the axilla is its disposition in two layers, one connected with and enclosing the pectoralis major, and the other and deeper layer enclosing the pectoralis minor, and being continuous above with the costo-coracoid membrane, and below with the so-called suspensory ligament of Gerdy, which plays an important part in cases of deep-seated axillary abscess. The large vascular trunks as they pass through the cavity, are surrounded by the brachial plexus, which here begins to spread out, the median nerve passing almost directly downwards to the inner side of the arm; the musculo-cutaneous nerve being directed outwards and downwards; the ulnar nerve inwards and downwards; and the musculo-spiral and circumflex nerves backwards and downwards. The thick and strong cords of the plexus are rarely torn through, save in cases of very severe injury, but are often compressed in cases of luxation of the head of the humerus, and also during the growth of a large tumour. The nerve which is mainly, if not exclusively, affected in instances of 'crutch paralysis' is the musculo-spiral.

The axilla, which is traversed by numerous branches from the main blood-vessels, is readily infiltrated and occupied by effused blood in cases of fracture and other injuries. In rapidly expanding tumours of the axilla this space is soon obliterated, the growth tending to extend most freely downwards, so as to project beyond its base and to separate the arm from the side of the chest. In sub-coracoid luxation of the head of the humerus the upper part of the space is occupied by the displaced bone.

Acute cellulitis of the axilla may occur either as a localised affection, or in association with a like condition of the arm or the whole of the upper extremity. In the former instance it is usually the result of inoculation with some septic virus, and is marked at first by deep-seated pain in the axilla. The integument soon becomes red and œdematous. As a rule this inflammatory affection is remarkably rapid in its progress, and the zones of invaded connective tissue rapidly undergo sloughing. The constitutional symptoms are generally very severe, and the patient often passes into a condition of intense septicæmia.

Circumscribed suppuration in the subcutaneous connective tissue of the armpit —*superficial axillary abscess*—may be due to local irritation, to lymphangitis, or intense cachexia. The abscess consists in a rounded fluctuating swelling, which is very tender and covered by tense and highly congested skin. In a case of this kind a free incision should be made at an *early stage*, in order to prevent penetration of the pus into the deeper portions of the axilla, and the formation of one or more obstinate sinuses.

Deep-seated axillary abscess may be acute or chronic, and again, either primary and dependent on some local cause, or secondary and due to the spreading of pus from some other region. A purulent collection in the axilla may be part of a larger abscess due to suppuration in the neck, to necrosis of the scapula, or to disease of the shoulder-joint. Instances have been recorded of empyema which had perforated the thoracic walls so as to produce a deep axillary abscess.

Primary acute abscess of the axilla is often the result of septic absorption, but may arise spontaneously or from contusions or sprains. The most frequent cause, however, is sympathetic glandular inflammation, excited by some wound or scratch or an open sore on the hand or breast. Whatever may be the cause of deep-seated abscess in the axilla, the arrangement of the fasciæ met with in this region plays a very important part in the seat of the purulent collection. The so-called suspensory ligament of the axilla formed by the process of fascia, which, after having enclosed the pectoralis minor, is inserted into the floor of the cavity, influences, at any rate in the earlier stages, the course taken by the pus. Hence, owing to this lamina, there are two forms of deep axillary abscess—one beneath the pectoralis major, the second at a greater depth, and beneath the pectoralis minor. In the former case the pus would make its way to the anterior border of the axillary fold, or in the furrow between the deltoid and pectoralis major. In the latter case, the pus, being bound down by the clavi-pectoral fascia, would have a tendency to surround the vasculo-nervous cord and to ascend into the neck, and might there infiltrate extensively the cellular spaces, and ultimately spread through the superior aperture of the thorax into the anterior or posterior mediastinum. There is often a tendency for the pus to burrow beneath the latissimus dorsi and into the subscapular fossa, and in some instances it has been known to extend as far as the brim of the false pelvis.

But few points of special import have to be mentioned with regard to the treatment of deep-seated abscess of the axilla. Suppuration being clearly indicated, it is necessary to afford vent to the pus without delay; and, after making an incision, it is well to use a director and dressing-forceps, as in other cases of opening a supposed abscess which is situated at some depth from the surface, and in the midst of important vessels and nerves. As the abscess-cavity contracts, care should be taken to keep the arm at rest and in contact with the side of the chest, as healing may be retarded by free movement of the limb, and fistulous tracks thus be established.

The most frequently observed of the many forms of *Glandular swelling* in the axilla are:—simple, acute, and chronic adenitis, strumous and syphilitic enlargements, secondary cancerous infiltrations, and lymphadenoma. Swellings of an inflammatory character, if acute, may in most instances be readily recognised, and usually there is evidence of some lesion of the lymphatics of the hand or of the thoracic or abdominal parietes. Such swellings do not of necessity run into suppuration. With chronic adenitis there is usually associated some well-marked cachectic condition. Syphilitic adenopathy, when occurring in the axilla, consists in the usual marked induration and slight enlargement of a few separate and freely movable glands, and is thus distinguished from the large lobulated and softened masses formed by the coalescence of glands undergoing strumous degeneration. Lymphadenoma, which often co-exists with like growths in other regions, presents a large and rapidly-growing but painless tumour of firm and elastic tissue, and with a generally smooth surface, marked at one or more parts by distinct lobular projections. The glands most frequently affected in cases of cancer of the mamma are those situated along the lower border of the pectoralis major and on the inner wall of the cavity near the superior digitations of the serratus magnus.

The *Tumours* met with in the axilla are mostly of glandular origin, but other forms of new growth occur, which either spring from adjacent bones or originate in the soft and proper structures of the cavity. Of the former the most frequent examples are hard (exostosis, enchondroma) or soft (carcinoma, sarcoma) growths originating in the scapula, the upper part of the humerus, or a rib. Of the second class of tumours many varieties have been observed—such, for instance, as cystic, lipomatous, fibrous, fibro-cystic, erectile, and primary sarcomatous growths. To these may be added a few instances of new growths connected with the nerves of the brachial plexus, such as neuromata and cysts. A very frequently noted characteristic of axillary tumour, even when of a very benign character, is rapidity of growth and consequent size, the large and loosely-packed cavity of the armpit favouring free expansion of the new growth, which in the early stages of the development causes but little if any disturbance, and is concealed by the pectoral muscles and the scapula. In almost every case of large or rapidly-developing tumour of the axilla, the attention of the surgeon is directed to a series of symptoms due to compression of the axillary blood-vessels and of the cords of the brachial plexus.

The subject of the *operative removal of axillary tumours* is one of much importance. A small and freely movable growth may in most instances be excised readily and with little danger. With regard to large growths which occupy most of the cavity and protrude beyond its inferior limits, the question of excision will be influenced by the diagnosis as to the nature of the tumour and the extent to which the large vessels and nerves, and also the integument, are implicated. Very large fibrous, fibro-cystic, and cystic growths have been successfully removed from the axilla, and in most cases of such forms of tumour operative interference may be considered as justifiable if the patient be in good condition. In lymphadenoma of the axilla the enlarged glands, according to Erichsen, form no attachments to surrounding parts, and may be readily removed by enucleation. The attempted removal of a very large lobulated lipoma or enchondroma is likely to be attended with much difficulty and risk, in consequence of the irregular extension of the growth around large vessels and nerves and into other regions. In the case of a very large, rapidly-growing, and fixed tumour, associated with considerable œdema of the upper extremity and indications of obstructed circulation and nerve-compression, the probability of a successful extirpation would be small, as both artery and vein, together with the cords of the brachial plexus, would almost certainly be found implicated in the disease. No attempt should be made to remove a large sarcomatous tumour, especially when the skin is ulcerated.

The enucleation of enlarged strumous glands from the armpit is usually a tedious and difficult operation, and is hardly justifiable, except in the rare instances in which the patient is in good condition and the glandular disease is very troublesome, rebellious to ordinary treatment, and limited to the axillary region. In the operative treatment of carcinoma of the breast, careful dissection of the axillary cavity and enucleation of both enlarged and apparently healthy glands have of late been advocated by many English and German surgeons. In operations of this kind, and also in the removal of any large axillary tumour, it will often be found necessary to make partial or complete division of the pectoralis major. The great danger is wound of the axillary vein or some large tributary. The knife should be laid aside as soon as possible, and the finger-nails and blunt instruments used to dislodge the growth, the surgeon taking care not to tear it away rashly and with too great force, as large venous trunks may be readily lacerated.

Wounds of the Axilla.—Serious direct and penetrating wounds of this region are not often met with, the cavity, especially when the arm is near the chest, being well protected on every side. In most instances of deep wound of the axilla, associated with division of a large vessel or nerve, the cause is a gun-shot wound, a sword-thrust, or a stab with a knife or dagger. A deep punctured wound, implicating merely a small arterial or venous branch, may, in consequence of the laxity of the axillary connective tissue, cause considerable effusion of blood and temporary distension of the cavity. In the case of a deeply penetrating wound, the absolute diagnosis as to whether the main trunk or a branch has been divided is uncertain and difficult. If the bleeding is very copious and the wrist-pulse cannot be felt, the main artery has very probably been wounded. The radial pulse, however, sometimes persists, though much weakened, in cases of partial division of the axillary artery. If there be much swelling and lividity of the upper extremity, with congestion of the superficial veins, the pulse being still perceptible, the injured vessel is very likely the axillary vein, although this is much less frequently wounded than the artery. If the hæmorrhage, at first severe, ceases or decreases, and the radial pulse can still be felt, the chances are that some large branch, either arterial or venous, has been wounded. Numbness of the upper limb, with more or less marked and diffused paralysis in connection with a punctured wound of the axilla, indicates a lesion of one or more large nerves.

In wounds of the axillary artery or one of its large branches, the results vary in different cases according to the extent of injury to the vessel and the nature of the wound in the skin and other structures of the axilla. Here, as in any other region traversed by a large arterial trunk, there may be very profuse and rapidly fatal hæmorrhage from a wide wound, freely exposing the injured vessel; or there may be repeated effusion of large quantities of arterial blood into the space in connection with a long and very narrow puncture, or, again, temporary arrest of the bleeding, with the formation, after a certain interval, of an arterial or arterio-venous aneurism. Two instances have been recorded of spontaneous cure of division of the axillary artery, but such a result must be very rare.

Treatment.—In the event of spontaneous arrest of hæmorrhage in penetrating wound of the axilla, it is better not to interfere at all, but to keep the patient quiet and carefully watch for any symptoms of arterial injury that may occur. Pressure, if it readily arrests the bleeding, should be gently and carefully maintained. In cases of free and persistent bleeding from a large open wound, or of rapid infiltration of the soft parts under the skin and fascia, an attempt should be *promptly* made to secure the artery at the seat of injury. The subclavian artery being commanded just above the clavicle by pressure, a steady dissection should be made down upon the wounded vessel, the surgeon being guided by the position of the external wound. If on free division of the infiltrated structures and removal of clots, the artery can be exposed at the seat of injury, this should be secured by two ligatures, one above, the other below, the wound, and the vessel, if not completely divided, be cut through between the points of ligature. The difficulty of finding the wounded artery may be so great, and the symptoms so urgent, as to lead the surgeon to have recourse to ligature of the subclavian in the third part of its course. The results of this operation, however, under such circumstances, have hitherto proved very unsatisfactory, and except, probably, in instances of but a small puncture of the axillary artery or one of its branches, it has almost always been followed by a renewal of the hæmorrhage. On failure of this procedure, amputation at the shoulder-joint will afford the only chance for the patient.

For the treatment of the remote results of wound of the axillary artery, *see* Axillary Artery, Aneurism of the.

Wound of the *axillary vein*, may, though rarely, be produced in any of the ways already mentioned, but most frequently occurs during the removal of a large tumour from the axilla. Sometimes only a branch is divided or torn by the surgeon; but this, when the injury occurs near the junction of such branch with the trunk, is as serious a condition as a wound of the main vessel itself. Such wounds are dangerous on account, not only of hæmorrhage, but of the entrance of air into the vein. Immediately profuse bleeding from a large vein is detected, a ligature should be applied. Should the main trunk be much wounded, it ought to be secured by a double ligature. Such practice, however, unless applied under antiseptic conditions, is not free from danger, as phlebitis and pyæmia may be thus produced.

Simultaneous wounding of both axillary artery and vein, though a serious injury, does not necessitate primary amputation at the shoulder-joint. Indeed, several records of this double injury seem to indicate that the patient is in a somewhat more favourable condition than after wound of only the artery. The hæmorrhage, according to Böckel, may soon cease, and an arterio-venous aneurism result, which may be more favourably dealt with than a large false or traumatic aneurism. *See* ARTERIO-VENOUS ANEURISM.

A subject of much interest in connection with axillary injuries, is that of wounds of large vessels in certain cases of dislocation of the head of the humerus. Such injury may occur in a recent case of uncomplicated dislocation, even when no attempt at reduction has been made; in a case of dislocation complicated by fracture; or—and these are the most frequent instances—in cases of old dislocation, treated either by very forcible extension or extreme abduction and elevation of the upper limb. The vascular lesion consists usually in either complete rupture of the axillary artery, or in separation of one of the large branches close to its origin. Some instances have been recorded in which the injured vessel was the axillary vein, and in some few serious hæmorrhage was caused by the rupture of several small arterial and venous branches. In those cases in which rupture of the axillary artery is caused simply by elevation of the arm in an attempt to reduce an old dislocation, some special conditions must exist to account for the injury; for the proportion of these unfortunate instances to those of successful reduction by much force of a dislocation of very long standing is very small. These conditions, it has been stated, are degeneration of the arterial walls and firm adhesion of the displaced extremity of the humerus to the surrounding parts, especially to the large vessels. In a collection of thirty-one cases published by Mr. Callender, in 1866, all the patients save one were over fifty years of age; but in a more recent and fuller table published by Dr. Körte, of Berlin, fifteen out of forty-eight patients were under this age, and six of these were between twenty and thirty years of age. In cases in which the luxation is quite recent, the vascular injury is due either to direct action of the head of the humerus, to unnecessary violence in reduction, or, in complicated dislocation, to a puncture by the sharp end of a fragment of bone. *See* ARTERIES, Rupture of.

In some cases of ruptured axillary artery the blood is poured out very rapidly into the subcutaneous soft parts of the axilla and chest and back, and the patient dies within an hour; in other cases a well-marked traumatic aneurism is developed within a few hours or days after the injury; and in others, again, the swelling is formed very gradually, and is not observed until after a considerable interval.

The prognosis in cases of this injury is most unfavourable, especially when the dislocation has been of long standing and the patient is advanced in years. According to Körte, who has studied this subject very carefully, in cases of small tumour not presenting the characteristic signs of an aneurism, the most suitable treatment is complete rest of the limb, with pressure over the axilla, the patient being carefully watched. In cases of rapidly-developed and undoubted aneurismal swelling, antiseptic ligature of the subclavian artery would offer the best, but a slight, chance of success. If the tumour have existed for some time, and its pulsation is not arrested by pressure on the subclavian artery, the only possible operative treatment would be incision of the tumour and double ligature of the wounded artery. EDWARD BELLAMY.

AXILLARY ARTERY, the, extends from the outer border of the first rib, whence it passes with a gentle curve across the upper part of the axilla, to end at the lower border of the teres major muscle. The artery is divided into three stages by the pectoralis minor.

1. The stage above the pectoralis minor, or first stage, passes from the first rib to the upper border of this muscle. In front are:—the skin, superficial fascia, platysma, and descending branches of the superficial cervical plexus, deep fascia; the pectoralis major, beneath which is a triangle—the clavi-pectoral—overspread by the clavi-pectoral or costo-coracoid fascia. Through the fascia pass the acromio-thoracic artery, the cephalic vein, and the external anterior thoracic nerve. On a plane anterior to and below the artery is the subclavian vein; behind and above, the cords of the brachial plexus; internally, the serratus magnus.

Ligation.—Three methods of incision are in vogue. 1. A semilunar from near the sternal to near the acromial end of the clavicle. 2. A straight incision along the clavicle with similar limits, to which a second vertical incision is added, separating the deltoid from the pectoralis major. 3. A vertical incision alone, separating the two last-mentioned muscles. The first-mentioned incision, commencing just below and external to the sternal end of the clavicle, is made by a sweeping cut downwards, ending at the anterior border of the deltoid. The coverings mentioned above are cut through, severing the pectoralis major from the clavicle. Feel for the edge of the pectoralis minor when the shoulder is pressed backwards, and pushing the finger still further backwards, recognise the pulsations of the axillary artery. Push the shoulder forwards, clear the artery of cellular tissue, and avoiding the vein in front and the cords of the plexus behind, pass the needle from before backwards, and obliquely from within outwards.

2. The second stage of the artery, that beneath the pectoralis minor, has this muscle in front; the vein internally and below; the cords of the plexus begin to surround the artery, but are still placed for the most part behind.

Ligation at this stage is performed by cutting, in the line of the artery, through everything till the artery is reached.

3. The third stage, or that beyond the pectoralis minor, ends at the lower border of the teres major muscle, i.e. some distance down the humeral shaft. In front are the cutaneous structures, and the pectoralis major for a short distance above; behind it rests on the subscapularis, latissimus dorsi, and teres major; internally and below is the vein. The cords of the brachial plexus are named outer, inner, and posterior, according to their relations to the artery; the median nerve lies in front.

Ligation.—Place the limb in the position of abduction, and rotate it outwards. The artery is found at the junction of the anterior and middle thirds of the axilla from before backwards, just under cover of the bulge of the coraco-brachialis. Make an incision along this line for three inches, cutting skin only; raise and divide the deep fascia upon a director. Pull the axillary vein backwards, when the nerves associated with the front and inner side of the artery appear. Draw the median nerve forwards, the internal cutaneous and ulnar nerves backwards, expose the artery, and pass the needle from behind forward.

James Cantlie.

AXILLARY ARTERY, Aneurism of the.—Aneurism of the axillary artery is probably met with more frequently than that of any other large artery save the popliteal, but, in the majority of cases, is due more to injury than to arterial disease. The tables that have been formed of recorded cases of this affection all include a number of instances of traumatic axillary aneurism from wound, laceration, or rupture, and of aneurism following a blow on the shoulder. As might be concluded from these facts, axillary aneurism occurs much more frequently in males than in females (12 to 1), and is more often met with on the right than on the left side. In fifteen cases collected by Mr. R. W. Parker, of spontaneous external aneurism in persons under the age of twenty, one only is included in which the axillary artery was affected.

There are certain special points to be noted with regard to the signs and symptoms of a typical axillary aneurism. In the first place, the swelling, as a rule, increases very rapidly. To the expansion of an aneurismal sac, as to that of a rapidly growing tumour, but little resistance is offered by the lax cellular tissue of the axillary space, and, in the course of six weeks or two months, a large and very apparent pulsating tumour may be developed. The tumour springs most frequently from the lower part of the artery, and projects directly downwards between the folds of the cavity. In cases where it arises from a higher part of the artery, it has a tendency to project upwards towards the clavicle, and occasionally even into the posterior triangle of the neck. The elevation of the shoulder so often observed in cases of large aneurism in the axilla is due, partly to pressure of the sac on the lower surface of the clavicle, and partly to constant voluntary efforts made by the patient to relieve compression of the cords of the brachial plexus. The sac of a large axillary aneurism may cause serious lesions both to the walls and contents of the cavity, and much disturbance in the blood-supply and innervation of the upper limb. The clavicle, or the first two or three ribs, may be eroded, and the sac, Böckel states, may project into the thoracic cavity or open into the shoulder-joint. The pressure of the sac on the nerves, as in cases of large solid tumours, causes numbness of the upper extremity and severe neuralgic pains. Owing to obstruction of the circulation through the axillary vein, the whole limb becomes congested, œdematous, and cold. The disturbance in the flow of blood through the artery may cause considerable diminution, or even complete arrest, of the radial pulse, and some loss of muscular power.

The *diagnosis* of true axillary aneurism is not usually attended with any difficulty. Several instances have been recorded in which experienced surgeons diagnosed the swelling as an abscess, but in these the affection consisted in a large diffused aneurism of traumatic origin. The conditions most likely to be confounded with circumscribed aneurism in the region of the axilla are those of a large and soft malignant growth, and of osteo-aneurism of the upper extremity of the humerus. In the former instance the clinical history and general condition of the patient with regard to cachexia and rapid emaciation, and in the latter instance the starting-point and situation of the growth, will probably serve to render the diagnosis clear.

The *treatment* of axillary aneurisms, which up to 1860 had consisted almost invariably in the application of a ligature to the third part of the subclavian artery, has since been much modified in accordance with more recent views as to the risks of the Hunterian operation when applied to this affection, the condition of the artery at the seat of aneurism, and the advantages of digital compression. In 1860, Mr. Syme advocated a return to the old method of treating axillary aneurism by incising the sac and applying a double ligature to the affected artery. The risks of ligature of the subclavian artery must always be great in consequence of the proximity of the sac and the free collateral circulation; and the old operation, even in the hands of the most experienced surgeon, must be regarded as a very heroic and hazardous proceeding. Save when contra-indicated by large size and rapid expansion of the sac, and by extreme elevation of the clavicle, digital compression should always be tried in cases of circumscribed aneurism of the axillary artery. This method has been strongly advocated by Mr. Holmes, who is of opinion 'that there are a great number of axillary aneurisms, both traumatic and spontaneous, which are amenable to gradual, intermitting pressure, when carefully applied to the artery above the tumour, and that in cases where this is not possible, from the pain which the patient experiences on pressure, the application of rapid total compression, under anæsthesia, may effect a cure.' If compression should fail, the surgeon may then have recourse to ligature of the subclavian, or, in the presence of any insuperable difficulties in the performance of this operation, to the old method as advocated by Syme; or, if the aneurism be of considerable extent, to removal of the upper extremity at or near the shoulder-joint. In instances of ruptured artery and large diffuse traumatic aneurism, it will be found necessary to expose the vessel and to secure it by ligatures above and below the seat of injury. EDWARD BELLAMY.

AXILLARY ARTERY, Wounds of the. *See* AXILLA.

AXIS, Fracture and Dislocation of the. *See* BACK AND SPINE, Injuries of the.

B

BACILLUS.—A rod-shaped form of micro-organism, belonging to the class of Schizomycetes (q.v.) and forming the genus Desmobacteria of Cohn.

Most forms are several times longer than their breadth, and the protoplasm is usually continuous within the cellulose sheath; in a few it is occasionally interrupted. The bacilli possess all the characters common to the Schizomycetes, but reproduction is brought about not only by simple longitudinal extension, followed by fission, but also by spore-formation. By fission, one rod has been found to double itself in twenty minutes at 35° C. In reproduction by spore-formation, the rod usually extends into a long filament (*leptothrix*), in the protoplasm of which there appear at intervals bright spots, which soon develop into (oval) spores. By the rupture of the filament these are liberated, and develop into rods by an extension at one point of their protoplasmic body pushing outwards the hyaline covering or sheath. Many bacilli, however, do not form *leptothrix* threads, and spores appear in the protoplasm of the adult rod, the sheath of which bursts, and the spore is freed. The presence of oxygen appears to be necessary to spore-formation.

(1) The SAPRIC bacilli, of special surgical interest as occurring in putrefying fluids, are:—

B. subtilis, found in putrid hay infusions and grows readily in animal fluids, e.g. serum, &c.

B. ulna. A much larger form, being more than twice as thick, found in putrefying animal tissues.

B. sapricus. A non-motile form found shortly after death in human blood-vessels (Klebs and Bond).

B. butyricus, found in fluids in which butyric fermentation is going on.

(2) The Pathogenic bacilli are of the greatest importance, as several diseases have been clearly proved to be due to their mycotic action.

B. septicæmiæ. (a) Of mice, Koch. An exceedingly small organism found in putrid fluids. Œdema is produced at seat of inoculation, the spleen is swollen, and the rods are mostly found in the leucocytes. (b) Of man, Klein. Also small organism, but larger than (a), figured by Klein, as found in lymph glands.

B. anthracis. This organism forms the poisonous element in splenic fever in animals, and malignant pustule (q.v.) and woolsorter's disease in man. It is found throughout the blood cramming the small vessels, causing inflammatory changes in the respiratory passages and lungs, swelling of the spleen (sometimes), and occasionally intestinal lesions.

B. anthracis symptomatici. The 'quarter evil' of animals, in which a hæmorrhagic œdema is produced at the seat of inoculation and consequent death from sapræmia (q.v.). The effects are proportional to the number of bacilli injected.

B. of malignant œdema (Koch), found in putrid fluids (? a form of *B. sapricus*) &c. Causes gangrenous œdema, with swelling of spleen and parenchymatous organs, together with petechiæ in and inflammation of serous membranes. The writer has twice seen similar organisms in traumatic gangrene, with similar post-mortem appearances.

B. tuberculosis. (a) Of man (Koch). A small organism, the protoplasm of which often has a beaded appearance. Found in the giant cells and caseous masses of tubercular lesions throughout the body; and when cultivated, inoculations produce a similar disease. The presence of the bacilli in sputum affords a valuable aid to the diagnosis of fatal phthisis. (b) Of animals. A similar though smaller bacillus is found in tubercular lesions of animals, the same being macroscopically different from the disease in man. It is doubtful at present if this form is communicable to man.

B. lepræ (Hansen). A small bacillus presenting the same behaviour to reagents as the *B. tuberculosis*; is found in enormous quantities in the corpuscles forming the leprosy nodules and thickenings of connective tissues.

B. equiniæ. A small bacillus found in the nodules, &c., of glanders both in man and animals.

B. nomæ (Lingard & Batt). In spreading ulcerative stomatitis, bacilli have been found at the margin of the disease. Death appears to follow from sapræmia, produced by swallowing the putrid discharge, since the writer has found a progressive anæmia, &c., in a case of this disease.

B. of swine plague (Klein). In swine-plague, the organs throughout the body contain bacilli closely resembling *B. subtilis.* The lesions produced are swelling of the spleen, pneumonia, necrosis of small patches in the liver, &c.

B. malariæ. Organism found in blood of malarious patients, which inoculated into rabbits produced a fever said to resemble malaria (?).

B. of choleraic diarrhœa from putrid meat (Klein), An organism found in two important epidemics of diarrhœa, fatal in five cases. The organisms were rounded at ends, and ·003—009mm. in length. Inoculation on animals produced similar fatal disease.

B. of lupus. In lupus corpuscles, &c., is found a small bacillus, the relation of which to syphilis and tubercle remains unknown.

B. typhoidus. A short thick organism found in the lymph-glands and spleen, in cases of typhoid fever. It is of doubtful importance.

For *B. choleræ*, see *Vibrio.*

Victor Horsley.

BACK AND SPINE, Injuries of the.—Here, as elsewhere, injuries may be met with ranging from the most trifling to the most severe. But there is perhaps no class of cases in which early diagnosis is more often difficult, or prognosis uncertain, from the fact that the slighter degrees of injury to the spinal cord or the offshoots from it, may at first give rise to no symptoms, and may lead to a sense of security as to the future which a more certain pathological knowledge would have proved to be unwarranted. But although the graver injuries of the spinal column, its fractures and dislocations, are usually fatal, or cause lifelong incapacity from simultaneous damage to the spinal cord, there nevertheless are not a few instances where recovery has taken place, or life been prolonged in comparative comfort, even after spinal injuries of apparently the most hopeless kind. The greater boldness in treatment which has followed a more extended pathological knowledge has shown us that the once hopeless view entertained of all fracture-dislocations of the spine is not altogether warranted. Not a few cases are now on record in which the reduction of a displacement or dislocation of the spine has led to a speedy subsidence of the symptoms which were due to pressure on the cord, and whose continuance was an exceeding danger to life, with the fortunate result of bringing about recovery, or at any rate of delaying the fatal end.

Sprains and Wrenches compose by far the largest proportion of the injuries to which the spine is exposed; and giving rise, as they often do, to severe and extensive pain, as a prominent symptom, they are liable to cause much hesitation and difficulty in diagnosis, and thereby lead to treatment unsuitable perhaps for their relief and cure. The cervical and cervico-dorsal regions, where movement is free and extensive, and in not much less degree the lumbo-dorsal region of the column, provide the most numerous instances of simple sprain, although no part of the spine can be said to be exempt therefrom, and now and then cases are met with where the whole vertebral column has been subjected to a severe wrench. Amongst the many causes of this injury, the commonest perhaps are the lifting of heavy weights, or the sudden and inordinate bending of the spine from indirect violence, whereby some fibres of muscle or ligament are stretched or strained, or it may be ruptured, either in voluntary efforts to straighten the column, or when unconsciously it is being held rigid and secure against the violence to which it is being subjected. Be the precise cause, however, what it may, the patient feels that he has ricked or twisted some part of his spine, and the local symptoms are usually such as are met with after a like injury in the neighbourhood of any mobile part or joint, and consist in local pain and local tenderness, stiffness and rigidity, and inability to move without suffering, and in the severer cases some undoubted swelling, either from extravasated blood or simple serous effusion.

It must be remembered, however, that such are the smallness and depth of many of the muscles and ligaments, that visible signs of injury are often absent, and we have to rely on the symptoms alone, their mode of onset, and the history of the injury. The local pain may come on almost immediately after the accident, and it is often extremely severe—a common experience after injury of muscular and ligamentous fibres; and this severity of the pain it is which too often leads to an erroneous belief in the existence of injury of deeper and more important structures. And when to this are added unwonted rigidity of the spine and inability to move without much pain, then the suspicion seems strengthened that the spinal cord or its coverings have not escaped injury. The suspicion is too likely to grow into belief, which, unfortunately, may lead to unsuitable or even harmful treatment, if the severity of pain on movement is such that the patient feels the greatest dread in moving at all, or if his attitude be so constrained and his gait so hindered that he presents a condition of pseudo-paralysis. Or again, in cases of severe lumbar sprain, the muscles and ligaments may have been so placed *hors de combat* as to lead to great difficulty in micturition and defecation, results which are by no means uncommon in lumbago, whether due to cold or injury, and which indicate how largely the ease and perfection of these acts depend upon the functional integrity of the muscles which support the spine. The combination of symptoms may suggest very grave inferences, though happily experience tells us that in the great majority of cases they indicate nothing more serious than muscular or ligamentous strain—an injury painful enough in itself, but rarely warranting a dread of future mischief, which may add to the patient's anxiety and thus retard his convalescence.

Far better, however, to draw an unwarranted inference from the symptoms than to fail to recognise the presence of injury to more important parts, for it cannot be forgotten that some of the ligamentous structures of the column are in close proximity to the spinal canal and the blood-vessels within it. Laceration of the posterior common ligament, for instance, cannot occur without risk of injury to the spinal membranes—not immediately, perhaps, by implication of them in the same lesion, but by extension of inflammation from the injured part, if sufficient rest has not been allowed for perfect recovery. So also the ligamenta subflava are in direct relation with the meningo-rachidian veins, and severe laceration of the one may be associated with rupture of the other. Hæmorrhage may thus arise within the spinal canal, not of itself perhaps sufficient to cause appreciable symptoms, but yet enough to be the starting-point of inflammation about the membranes and, it may be, of ultimate degeneration of the spinal cord. Herein lies the danger of any form of accident whereby the spinal column has been inordinately bent, that some one or more of the structures which are contiguous to internal parts may have been hurt, and there are no special signs or symptoms at hand to show that such has been the case.

Perfect rest is at first essential, not only to permit subsidence of swelling, whether superficial or deep, visible or out of sight, and to allow of repair of the injured muscular or ligamentous fibres, but also, and of even more importance, to avoid the risks of inflammation which want of quiet may engender in and about the injured parts. The length of time during which absolute rest is necessary must depend upon the extent of the injury and the mode of the accident, but better too much rest at first than too little. As the pain on movement lessens, so we have an indication that movement is less undesirable than before. The continued application of warmth is most comforting to the patient, and nothing is so beneficial perhaps as a large linseed poultice in which he may lie. For internal medicinal treatment there is usually no call, unless the patient be the subject of rheumatism or 'rheumatic gout,' when, as is well recognised, any muscular or ligamentous pain is likely to be severe and troublesome, and therefore, it may be, to demand the administration of alkalis, of iodide of potassium, of salicylate of soda, or quinine. Constipation must be relieved by occasional aperients, or better by simple enemata, and difficulty in micturition had better be met by the careful use of a soft catheter.

Sufficient rest having been given, the later treatment must consist, as in the case of the larger joints, in movement rather than in fixation and enforced rigidity of the affected part. This is frequently one of the surgeon's chief difficulties, for the pain on movement may be so considerable, and so prone to return for some time after it seemed to have disappeared, that the patient can hardly believe that movement, which at first may aggravate his pain, should be the proper treatment to remove both pain and stiffness. Movement and the application of heat may be combined, while the patient is still in bed, by the old remedy of ironing the back with a hot iron, a means of treatment very often beneficial from the heat compelling the patient to shrink and move, and thus calling into action fibres over which he might not otherwise be able to exert the influence of his will. The relief is often striking; as we see after the manipulation of a joint stiff from sprain, the passive movement soon becomes active, and with the disappearing stiffness the local pain and tenderness considerably subside. It is in these cases that great benefit may be derived from systematic exercises on the Zander method; and the daily application of the continuous or interrupted current to the affected parts, or, better, of both combined, may sometimes give relief when other means have failed. It is essential that the current be strong, and that it be brought to bear on a considerable extent of surface by the use of large flat plates.

In cases of severe contusion or sprain of the dorsi-lumbar spine we sometimes meet with hæmaturia, the result of structural injury to the kidney. By itself the symptom is not serious, unless the amount of bleeding be very large, and even then it is amenable to treatment by the administration of ergot or gallic acid, with perfect rest. The bleeding usually subsides in course of time, as the breach in the kidney becomes repaired, and there is no evidence to show that such an injury is liable to give origin to a chronic nephritis. Lacerations of the kidney by themselves are not commonly fatal, and it is rare to have an opportunity of post-mortem examination, unless there be some other serious lesion which complicates the case.

SPINAL INJURIES OF RAILWAY COLLISIONS.—What has been absurdly termed the 'railway spine' is an affection of the spinal column essentially similar in all its characteristics to the injuries already described. It is a common experience after railway collisions to meet with many cases where there is complaint of pain either about the spinal column itself or in the muscular structures on either side of it; and the combination of symptoms is precisely such as we meet with after other and less special forms of accident. The only difference—if, indeed, difference it be—consists in the fact that many diverse parts of the spine may be affected at the same time. Cervical, dorsal, lumbar, and sacral regions may each and all be simultaneously wrenched or sprained, and as a consequence there may be very severe suffering throughout the whole spine and its neighbourhood, causing much alarm as to the extent of the injury, and inducing a belief that some serious lesion has been inflicted on central structures. The mode of accident is precisely such as would be expected to give rise to spinal wrench or sprain, for the victim of a collision is thrown backwards and forwards in the carriage, and during this violence—against which he is well-nigh powerless—the muscles and ligaments of the spine, as of other parts, are 'set,' or unconsciously contracted, in order to render the spinal column rigid; and thus it happens that the brunt of the violence falls on those structures whose office it then is to prevent undue bending of the spinal column and damage to the important organ within. The result is spinal wrench or sprain, giving rise to acute pain on movement, to local tenderness, to great stiffness, to difficulty in micturition and defecation, and to that sense of weakness in the legs which is common in lumbago, and which is due to the muscular and ligamentous structures of the spine having been rendered functionally inert. And, in the very severest degrees of this form of injury, it seems probable that there is sometimes strain or stretching of the nerve-trunks as they pass outwards through the spine, as evidenced by tingling or pain in their peripheral distributions.

The pain may come on almost instantly after the accident, or it may be delayed for some hours or days, until, by some particular movement, those fibres which have been injured are called into action and their damage is thereby revealed. The cases may vary in every degree of severity, from slight pain lasting only for a few days, to pain and tenderness and stiffness abiding for many months, and causing long-continued incapacity. Unfortunately the sufferers from this form of accident have to contend against influences which may very seriously retard their progress towards recovery. In the first place, it is unusual to find that a spinal sprain is the sole injury received. The circumstances of many collisions are enough to produce a very profound effect upon the whole nervous system, and symptoms may in consequence be developed indicative of very considerable functional disturbance of both cerebral and spinal centres. A condition of nerve-exhaustion or neurasthenia is induced as the result of severe shock—in the judgment of the writer, of shock from fright—which manifests itself in various ways, and complicates the vertebral sprains which otherwise would seem of less importance, and be no less amenable to treatment than sprains inflicted in other accidents. There arise derangements of the circulatory and vaso-motor systems, as shown by palpitation, alternate sensations of heat and cold, sweating, diarrhœa, menorrhagia, and polyuria; sleeplessness, restlessness, nervousness, loss of memory or inability to sustain attention, asthenopia, loss of control over the emotions, early fatigue, whether from physical or mental efforts—symptoms all indicative of some change wrought on the nervous centres, cerebral, spinal, and sympathetic, whereby they are rendered functionally incapable of the same work or control over other organs as before.

Very variable, also, in degree and in duration, may such symptoms be. The exhaustion may be slight and temporary, or may be so profound as to place life in peril, and cases are not unknown where death has occurred from simple nervous exhaustion, without any discoverable pathological changes. The effect is, doubtless, to a large extent, dependent on the nervous temperament of the individual, and experience shows that those in any way predisposed to nervous disorders, who inherit a nervous diathesis, or in whose families nerve-disease is common, are especially prone to suffer from such symptoms after railway collision. Recovery, however, is the usual rule, with appropriate treatment and after adequate time, every effort being made to secure perfect rest of body and mind, and the avoidance of everything conducive to mental worry and anxiety. And this other circumstance may have a potent influence in delaying convalescence—that the sufferer receives compensation in money for the injury sustained. It is unnecessary to enter at length into this matter here; suffice it that the hope of compensation is abundantly proved by experience to interfere very seriously with recovery. While in some cases it acts, doubtless, as a temptation to gross exaggeration and imposture, especially where the injury has been slight; in other and more numerous instances it merely acts as a hindrance to recovery, by preventing the requisite voluntary effort being made to throw off the invalid state. For the sufferer knows that, as long as compensation is to be had for his incapacity, there is no occasion for him to do the best he can to earn his own living by resuming his daily work.

In not a few instances, also, there is a nervous, but really honest, dread lest some mistake be made in the settlement of a rightful claim, quite apart from the worry that is necessarily incidental to legal proceedings. And thus the want of occupation, the invalid life of comparative comfort at another's expense, the uncertainty and unsettlement of mind when a man is waiting to see how his case may turn out, make him alive to every morbid sensation that may arise, and foster a state of chronic invalidism which is the result of his present mode of life rather than of any injuries received. On the one hand, the want of movement and exercise perpetuates the pain and rigidity of his spine; and the general circumstances of his state, upon the other, tend largely to keep up those symptoms which are cerebral rather than spinal, and the best hope of recovery from which depends, most surely, on the return to a natural mode of life. Hence the phenomenon is not uncommon of the very rapid recovery of patients after compensation has been received, not because they have been wanting in *bona fides*, but simply because the chief obstacle to recovery has been removed.

The line of treatment to be followed in spinal wrenches and sprains has been already indicated, and for the general condition of neurasthenia we must be guided by the grand principle to secure adequate rest for the organs which have been disturbed, and especially for the brain. On all persons who have been shaken in a railway collision the advisability of complete abstinence from bodily and mental fatigue, for a time proportionate to the injuries received, should be enjoined. Here, a few days may suffice to bring about perfect recovery; there, a much longer period may be necessary; but of this there can be no question, that any endeavour to walk off the effects of the accident, or to work in spite of the brain-exhaustion so early felt, will only prolong the illness, and may bring forth symptoms which otherwise would never have appeared. No medicinal treatment is of any special avail. Rest must be secured at night by one of the narcotics, if need be, in ordinary use; and the writer would say a word in favour of opium, too much neglected nowadays in the treatment of the sleeplessness and exhaustion which are so often seen together. A note of warning cannot be withheld against the frequent administration of bromide of potassium in these cases of neurasthenia. An admirable remedy for securing sleep at night, either alone or combined with chloral or cannabis indica, it is wholly unsuitable as a sedative to compose 'the nerves,' whose agitation is rather an evidence of exhaustion and loss of control than of superabundant energy from central irritation. Given in large and repeated doses throughout the day, bromide of potassium is fraught with the gravest evil, for it merely acts as a powerful depressant, and keeps up the very condition of nervous exhaustion which we are anxious to remove. Cases, not a few in number, have come under the observation of the writer, where to the symptoms of neurasthenia from railway shock have been added those of bromism from poisoning with this drug, and where improvement has begun the moment it has been withdrawn.

Intraspinal Hæmorrhage. — Some of the spinal ligaments are closely contiguous to vessels in the spinal canal, and, as a consequence of the severest degrees of bend or sprain, we may have laceration, not only of muscular and ligamentous fibres external to the spinal canal, but of vessels also which lie within it. Hæmorrhage may thus arise, and blood be poured out within the spinal canal, and, if sufficient in quantity, may give rise to definite symptoms. These, however, are rarely the symptoms of loss of blood, but are rather due to the pressure of the effused blood upon the cord itself, or on the nerves coming off from it. Impaired innervation of the parts below the seat of lesion is found, amounting either to total paraplegia, or to some less serious impairment of motion and sensation. The difficulty of diagnosis in these cases is often extreme, for the surgeon has to decide between the existence of grave cord-lesion, and simple pressure on the cord from extravasated fluid.

The history of the accident, and the progress of the symptoms, often provide the only clue; and as, after injuries to the head, gradually deepening coma is often the chief symptom of hæmorrhage within the skull, so the early advent of a paralysis which steadily increases until complete, or almost complete, paraplegia has been reached, after some accident likely to cause severe spinal wrench or sprain, may help to exclude the existence of any graver injury than hæmorrhage. And this sequence is of especial value where the symptoms have not followed instantaneously upon the accident, as is the usual result of simultaneous crush of the cord in fracture-dislocations. The blood may be poured out between the dura mater and the bone, or within the sheath of the dura mater itself, but the symptoms give no evidence of the exact site of the blood, and depend wholly upon the quantity effused.

Treatment must be directed to lessen the hæmorrhage, and so to limit the possible damage to nervous structures, for any continued pressure upon the cord must not only interfere with its functional utility, but may also lead to pathological changes in the cord itself. Absolute rest, the application of ice to the spine while the patient lies upon his face, and the administration of ergot, are possibly the best means for staying the bleeding, though, unhappily, its tendency is to increase, on account of the laxity of the tissues into which the blood is poured. The gravity of the symptoms is due, not to the amount of blood alone, but to the position of the hæmorrhage; for, as in dislocations and fractures, the higher the seat of the lesion, the less chance is there of recovery, or even of prolongation of life. Cases have not been few, however, amongst the comparatively rare instances of this injury, where the hæmorrhage has been low down in the spinal canal, and where there is every reason to believe that the blood has been absorbed, and recovery has been complete.

Short of this result, however, there is the possibility of some permanent damage by pressure on the cord or nerve-roots, some abiding impairment of motion or sensation in the parts below the seat of lesion; while the tendency of secondary degeneration to spread in the direction of certain 'centres' in the cord, may make a small and otherwise unimportant hæmorrhage the starting-point of wide-spread disease. Treatment in such cases must be persevering and continuous. Perchloride of mercury and iodide of potassium, or ergot, with counter-irritation by blisters to the spine, may lead to the absorption of the remaining blood, or of any inflammatory lymph which may have been effused around it; while the systematic exercise of the limbs in those movements which have been impaired or lost, with the aid of electrical treatment properly applied by competent hands, may do much to reopen those nervous channels which have been blocked at the seat of lesion.

LACERATION OF MEMBRANES AND TRAUMATIC MENINGITIS.—This is happily a rare occurrence as the result of simple sprain of the spinal column. The acute form is most commonly induced by gunshot or other injury, which lays open the theca vertebralis, and seriously damages other parts as well. Inflammation starts at the seat of wound, and thence spreads rapidly upwards and downwards until the whole cord perhaps is bathed in pus. The same course of events has been known to follow some less serious lesion of the spine, either, it may be, from septic contamination, or from previous ill-health of the patient. The rapidity with which inflammation spreads is sometimes terrible, and amply justifies the term 'foudroyant' which has been applied to this form of meningitis. Ushered in with rigors or shivering, the temperature soon runs high; tenderness and pain are more or less marked throughout the spine, with dread of being touched or moved, and irritation of the roots of the nerves gives rise to extreme restlessness, to muscular spasm, and widespread cutaneous hyperæsthesia or tenderness. Opisthotonos, too, may occur, either from irritation of the posterior cervical and dorsal roots, or as an instinctive means of relaxing the muscles in order to relieve pain. Vomiting and delirium may also be prominent, and the patient rapidly wastes. Death occurs early, and we find *post mortem* a layer of lymph, in which the amount of pus may vary, on the inner surface of the dura mater, while the meshes of the pia mater are distended with sero-purulent exudation. As to treatment, it is impossible to speak with any degree of hope. Ice should be continuously applied to the spine, and it may be well to try the effect of repeated small doses of calomel, so as to bring the patient rapidly under the influence of mercury. Ergot, belladonna, and aconite have also been recommended, but it is very questionable whether any medicinal influence can be brought to bear on the cause of the inflammation.

Not less important than cases of acute traumatic meningitis are those where the meningeal inflammation is sub-acute or chronic, and where the absence of any definite symptoms of inflammation *per se* leads very often to the greatest difficulty in diagnosis. The development, however, of a low form of inflammation which leads to thickening and induration of the spinal membranes, and their adhesion together or to adjoining parts, is one of the results to be feared after any and every severe wrench of the spine—a kind of accident which may be calamitous in the future because we are at a loss to know whether the injury has really been of such a nature as to lead to meningitis, or to tell how and when it may begin. It can only be conjectured that it arises as an extension inwards of inflammation from some point of injury or irritation in some part of the spinal column external to, or immediately adjoining, the spinal canal. Pain and local tenderness and spinal stiffness are such ordinary evidences of simple and even slight sprain, and are so often absent even when pachymeningitis exists, that alone they are untrustworthy signs of subacute intra-rachidian inflammation, and unless there be some distinctive symptom of nerve-disorder a diagnosis can only be most uncertain. Pain or hyperæsthesia in the region of special nerve-distributions, alterations in the reflexes, departures from the normal reaction to electricity of different muscles, anæsthesia in various degrees, impaired motor power, atrophy or rigidity of individual muscles or of groups of muscles with the same nerve-supply, are therefore of much greater value as symptoms of some meningeal thickening than are spinal tenderness, stiffness, and pain.

It is in these cases that from very small beginnings much havoc may be wrought by secondary degeneration of the nervous centres, and it is therefore all the more incumbent on the surgeon to pass by no symptoms suggestive of meningeal inflammation in the very earliest moments of the disease. And in chronic meningitis, with its various consequences, as has been seen already in acute, one has, unfortunately, too often to recognise the futility of treatment, and the only hope may lie in the possibility of a syphilitic taint being at the root of the mischief. The long and persistent administration of iodide of potassium and mercury, separately or combined, may help here, as in other late manifestations of acquired syphilis, while in the absence of that taint they may possibly tend to the absorption of simple inflammatory products. Nor should we fail to make use of counter-irritation, in the shape of blisters to the spine—a mode of treatment once in common vogue for spinal diseases, but now, perhaps, too much neglected or despised.

Fractures and Dislocations of the Spine.—Simple dislocation without fracture is not so uncommon as it was at one time thought to be, and it is in such cases, rather than in cases of fracture or fracture-dislocation, that recovery is most likely to ensue. And the reason thereof is that in simple dislocation the spinal cord is much less liable to severe injury, that its structure is less likely to be disorganised by the crushing into it of sharp fragments of bone, and that there is a better chance of being able to remove the simple pressure which the displaced vertebræ are exercising upon it. Thus accurate diagnosis is, if possible, of supreme moment. That a grave injury has been inflicted on the cord can be told at once with only too much certainty, for on that point the immediate paraplegia leaves no doubt; but we have to discover how and where the lesion has been caused. The point where can be learned by application of our knowledge of nerve-distribution, and by deciding the line—often a hyperæsthetic line—where palsy begins; but the manner how, whether by instant crush from displaced bones, by the simple pressure of extravasated blood, by severe bend and therefore disorganisation of the cord, or by simple concussion of the cord, is frequently a matter of the greatest uncertainty. We have to fall back upon a history of the accident, and upon careful examination of the spine itself, to feel or see whether there be any projection or displacement obviously discoverable by physical signs.

The presence of a projection, and therefore of displacement, should at once raise the question whether steps should not forthwith be taken to reduce it, so that the surgeon may remove the pressure from the cord, and give the best chances of recovery. If the cord itself be undamaged, and the paraplegic symptoms be simply due to the pressure of displaced bone upon it, then—as the record of several cases has proved abundantly—the symptoms may at once subside, and recovery may in the end ensue, when time has been given for repair of the spinal injury. And even when there is something worse than simple pressure, and the cord is being lacerated by some sharp fragment of bone, the reduction of displacement may perchance release the cord, and thereby lessen the risks of inflammation and add to the chances of life. Help in diagnosis may be obtained from knowing the site of the injury; for of the three regions, cervical, dorsal, and lumbar, pure dislocations are found most often in the first, and as we go lower down dislocations become rarer and fractures more common, though commonest of all are the two combined. In whatever region dislocations occur the intervertebral substance is more or less torn and lacerated, and, as a rule, the vertebra which is upper at the seat of separation, carrying with it all the vertebræ above it, is dislocated forwards on that which is below, as, for example, the fifth cervical upon the sixth; and *post mortem* we never find a vertebra separated from both its neighbours. One or both of the articular processes are usually at the same time dislocated, while there is an almost infinite variety in both the character and degree of the injuries to ligamentous structures.

Everything, doubtless, depends on the mode and severity of the accident, whether the separation be great or little, whether it be, or be not, associated with fracture, and whether the cord be much or little damaged. Here, again, there is infinite variety. In the cervical region, for example, there may run, in connection with the dislocation, a line of fracture through the spinous processes or the laminæ of the displaced vertebra and its neighbours. There may also be fracture through one or more of the bodies, but whatever the precise lesion, whether in this region or in others, it sometimes happens that by its own natural resilience, and by that of its various ligaments, the displacement is only momentary, and the spine at once springs back into its natural position. But in that moment the damage to the cord was done. Lower than the cervical region pure dislocations are extremely rare, for, in consequence of the anatomical formation of the dorsal and lumbar vertebræ, a much greater force is necessary to produce separation, and fracture with dislocation is almost invariably found. The line of fracture may run through almost any point of the vertebral arches; there may be endless variety in the extent of the displacement of parts so detached, and very commonly there is fracture through a vertebral body also. The chances of successful reduction of displacement in the lower parts of the column are, unhappily, small, for it is well-nigh impossible to use sufficient force in the right direction, and it is questionable whether in any but a small minority of cases good will result from prolonged attempts to replace the parts in their proper relative positions. Post-mortem examination proves only too clearly that the displacement is often permanent and irreducible, and that the spinal cord has been irreparably damaged. It is found soft, pulpy, and diffluent at the seat of injury, either because it has been crushed by the displaced bones, or because its structure gave way in the excessive bend to which it was subjected. For these injuries, in whatever region, are most commonly caused by some severe and sudden bend of the spine, usually from indirect violence, in such a manner that the spine is bent upon itself, the weight of the parts above and below the site of bend adding momentum to the original violence.

Cases are not few where a wholly unsuspected fracture—‘latent’ fracture, as it has been termed—has been found after death, while both the nature of the accident and the symptoms afterwards had led to the belief that none was present. Settled pain in the region of one or two vertebræ, increased by manipulation of the spinous processes, and a sense of weakness or want of support at one point of the back, may be the only symptoms present—symptoms wholly subjective, but nevertheless deserving of great regard in face of the risk of secondary implication of central structures. Extravasation of blood within the theca vertebralis, meningitis, myelitis, suppuration,—these are the dangers to be feared, and we name them, not because they are common results of simple fracture without immediate injury to parts within the canal; but rather as a warning, and forcibly to urge the need of taking all conceivable care until time has been given for reunion of the fracture.

DISLOCATIONS OF CERTAIN VERTEBRÆ.—Dislocation of the *occiput from the atlas* is so rare that it may be left out of account in treating of spinal injuries, but dislocation of the *atlas from the axis* is by no means uncommon, as the result of falls upon the neck or head, or of any sudden strain upon the uppermost part of the spine, such as must be caused in execution by hanging. Death is usually instantaneous from crush of a vital part of the cord, for the rupture, which is almost invariable, of ligamentous structures—of the transverse ligament usually, of one or both check ligaments according to the nature and violence of the accident—allows the cord to be pressed forwards from behind and squeezed against the odontoid process. A like result may ensue from sudden and violent rotation of the head, whereby one of the check ligaments is torn, and laceration of others immediately follows. Instant death is the usual rule, but even in this region, bearing within it structures essential to life, there are exceptions.

Dislocations, uncomplicated with some fracture, are almost unknown between *the axis and the third vertebra*, separations between the first and second being the usual injury in this part of the neck. The cases, however, are numerous in which there has been fracture, with or without displacement, of the upper vertebræ, both from direct and indirect violence, and not a few where union has taken place and death been due to some other cause. It is in the lower part of the neck—below the third vertebra, that is—where dislocations most commonly occur, giving rise, in addition to the symptoms of cord-injury, to local pain, undue mobility, deformity, irregularity or gaping of the spinous processes, and, in some instances, well-marked projection in the pharynx, with, it may be, difficulty in swallowing. Reduction should be attempted, if need be under the influence of an anæsthetic, as soon as possible, warning having been given beforehand, both to the patient and his friends, that the procedure of reduction is not without its own immediate dangers.

Unilateral dislocations may occur in the cervical spine; separation of an inferior articular process from the superior of the vertebra next below it being sometimes caused by sudden and extreme rotation of the neck, or even by turning the head too sharply to one side. The diagnosis is comparatively easy; the face is turned and fixed towards the side opposite to the injury, there is obvious deformity and local pain, and more or less of paralysis. Reduction must be undertaken at once, by forcible traction on the head, so as to disengage the processes, and then turning the head and upper spine into their proper axis. Counter-extension may be obtained by placing the knees against the patient's shoulders, and success is often indicated in the reduction of this dislocation, as of others which are bilateral, by an audible snap. The prognosis is favourable or the reverse according to the amount of palsy—of probable damage, that is, to central structures—and to the presence or absence of fracture. The after-treatment should obviously be directed to securing perfect rest and immobility for several weeks after the accident—a matter of no small difficulty, it may be, in bilateral dislocations when continuous extension may have to be maintained in order to prevent a return of the dislocation.

Paraplegia, or paralysis of motion and sensation—of motion, usually, more complete than of sensation—of all parts below the seat of injury, enables us to fix the level of the spinal injury and of the cord lesion; in the estimation of which it must be borne in mind that the cord is usually crushed at, or a little below, the level of the lower border of the displaced vertebra, and that the nerves issue from the spinal canal at a lower level than their origin from the cord. Their obliquity within the canal gradually increases from above downwards, and the nerve-supply is thus interrupted lower than the number of the displaced vertebra implies; while conversely, when we are endeavouring to decide the site of spinal injury by noting which nerves are completely paralysed, the fracture is really higher up than the level at which such nerves come out of the spine. Prognosis depends materially upon an accurate knowledge of the site of the lesion. The higher we ascend in the column, the greater is the danger to life, for the nearer are we to the respiratory centres, whose early involvement in inflammation is surely fatal. The cervical nerves, the eighth alone excepted, are named, it must be remembered, from the vertebra above which they come out, and the fourth cervical nerve, which chiefly supplies the diaphragm, issues above the fourth cervical vertebra, and upon the implication of its centres virtually depend the chances of recovery, and the length of life. Cases are on record, however, in which life has been prolonged even after severe damage to the cord above the origin of the phrenics—a circumstance due, in all probability, to the fact that the cord had not been injured in its entire thickness.

The chances of life are naturally much lessened when diaphragmatic breathing alone remains, the thoracic muscles of respiration being paralysed. The diagnosis of this form of breathing is free from much difficulty, its departure from the normal being most striking and characteristic. The thoracic walls do not remain motionless, as might be expected from palsy of the muscles which move them; but, by the influence of atmospheric pressure, they move at the wrong time, sinking when the diaphragm descends, and rising somewhat suddenly when the diaphragm becomes flaccid. Thus the enlargement of the chest-cavity, from contraction of the diaphragm, is counteracted by sinking in of the chest-walls just at the very moment when they ought to be expanding, and extra work is thus thrown upon the diaphragm. Respiration therefore becomes gradually more and more embarrassed, although sometimes it is marvellous how long life may continue with diaphragmatic breathing alone. The lower the seat of injury, the less likelihood is there of the cord having been entirely destroyed, and the cases are not few in which after fracture-dislocation in the lower dorsal and lumbar regions, there has been recovery sufficient to allow of very fair enjoyment of life. In such cases it is most important to re-educate the paralysed muscles, so soon as time has been allowed for consolidation of the fracture; for if any healthy structure remains, the functional restoration of the cord may be materially advanced both by exercise of the will upon the paralysed muscles, and by the proper and persevering use of electricity, by galvanisation of the cord and of the nerves and muscles below the seat of lesion, to call them into activity and reopen the obstructed paths in the medulla. It is a great mistake to rest satisfied with life having been spared, and not to make most strenuous efforts at an early date to bring about some restoration, be it only partial, of the functions of the cord.

Paralysis of the bladder, as a usual rule, is complete, owing to the fact that both sets of muscles which govern the act of micturition are paralysed. But we may have palsy of the one without the other, and the separate and seemingly contradictory phenomena of retention and incontinence. The sphincter vesicæ and the detrusor urinæ have, in all probability, distinct and antagonistic centres in the cord. The healthy act of micturition consists in reflex excitation and action of the detrusor with, at the same time, inhibition of the centres of the sphincter, which thereupon relaxes; and although these centres usually act automatically on the requisite stimulus, they are under voluntary control during the integrity of the spinal cord. If this integrity be destroyed by lesion above these local centres, paralysis will be complete or incomplete according to the amount of interference with the spinal centres themselves. Let the centres *per se* be unaffected, and the cord destroyed higher up, all voluntary control is cut off, and micturition may occur in a seemingly natural way from time to time as the bladder fills, without the knowledge of the patient. On the other hand, the character of the act may vary according to the affection of the local centres themselves. Opinions have differed as to the advisability of using the catheter in these cases, some surgeons deeming it unnecessary, others fearing that cystitis may be caused thereby. There need, however, be no difficulty in avoiding the introduction of septic or unclean matter into the bladder by the use of an instrument which is perfectly clean, for which purpose it is well to keep the catheter continuously in carbolised water; and there can be no question as to the desirability of preventing the patient, or his bed-clothes, from being perpetually soaked in urine. On the whole it seems better to use a soft catheter morning and evening, or oftener if need be, to ensure the complete evacuation of the bladder, to avoid the smell of incessant urinary flow, and to keep the patient dry. But, above all things, let care be taken that the catheter is absolutely clean, and that it be passed with all tenderness.

The act of defæcation, like that of micturition, is a complicated one, for although under voluntary control, it is also under the immediate influence of spinal centres, of which one is for the muscles of expulsion, the other for the sphincter to close the orifice. Contraction of the one set of muscles, and relaxation of the other ordinarily go together; but if voluntary control be withdrawn, defæcation may occur unknown to the patient, whenever his rectum is sufficiently loaded to excite the reflex act of expulsion, the sphincter being at the same time paralysed. The rectum, however, is not so continuously filled as the bladder, and there is no constant discharge of fæces, as there is of urine when the sphincter vesicæ is paralysed. Be the precise nervous mechanism what it may, the difficulty and duty arise of endeavouring to keep the patient clean and dry. Occasionally, however, we meet with the opposite trouble of constipation from the normal peristalsis of the intestines being annihilated, and to this may be added alarming tympanites from palsy of the intestine.

Interference with the normal action of yet other supposed centres in the cord gives rise to a symptom very often met with in cases of fracture-dislocation, i.e. priapism —a vascular turgescence, or quasi-erection, of the penis, which is most frequently seen after injuries high up, but which may be present when the lesion is quite low down, even in the lower dorsal or lumbar region. This used to be regarded as a symptom of grave import, but probably without due warranty, for there is no evidence to show that, by itself, it is a more certain evidence than others are of grave and fatal injury to the cord. The precise manner in which priapism is caused is not known. By some it is thought to be a merely passive condition, due to vaso-motor palsy, which permits filling and distension of the vessels of the erectile tissue; while others look upon it as due to irritation of supposed sexual centres in the lumbar portion of the cord.

Few questions in connection with these injuries of the spine and spinal cord are of greater interest than the variations of temperature observed in different cases. It seems impossible to predict of any injury that it will be followed by a high temperature or by a low one, and little more has yet been done in elucidation of the differences than the careful observation of unusual examples of one condition or the other. Excessively high temperatures of the paralysed parts have been most often met with in injuries of the cervical cord; but yet very low temperatures have been noted in apparently similar cases, while in some an early high temperature has been followed by an abnormally low one until the time of death. As far as can be told, there is no special lesion to account for these differences. It has been observed, however, that in cases of high temperature the pulse is usually full and bounding, while in the opposite the pulse is small and feeble, and to Mr. Hutchinson we owe the suggestion that the character of the circulation really determines the degree of temperature. Parts paralysed naturally develop less heat, and when nearly the whole body becomes a cooling area, as after cervical injuries, the bodily temperature will be low unless the strength of the circulation be such that the free supply of blood to the paralysed area not only prevents a fall in temperature, but even creates a balance on the other side. Notwithstanding thermometrical observations, the whole question of temperature variations is still very obscure.

Bedsores and changes in the urinary excretion demand the attention of the surgeon; for, though not adding materially to the patient's suffering, they have their own special dangers. *See* BEDSORES; BLADDER, Diseases of the.

CONCUSSION OF THE SPINAL CORD.—The question whether there is such a thing as true 'concussion of the spinal cord' need not long detain us. That the brain may be structurally injured by pure concussion is of course an accepted fact within the experience of all, but it is a wholly different matter with reference to lesion of the spinal cord. Medical literature, it is true, contains not a few cases of traumatic lesions of the cord, which have been attributed to the effects of concussion; but in the judgment of the writer this has been the result of a too ready trust in a supposed analogy between the brain and the spinal cord. It has not been sufficiently recognised that the physical surroundings of these two organs are widely different; and it does not follow in the least that because they are parts of one system they are therefore both liable to the same form of injury. The brain is so lodged in the skull as to be especially prone to suffer structural injury from concussion-blows upon the head; the spinal cord, on the contrary, surrounded by fat and fluid and suspended to the sides of the chamber in which it lies, is placed so as to be securely protected from any evil consequences of similar injuries to the back or spine, and the analogy between brain and spinal cord is in this respect deceptive and unwarranted. Nevertheless there are cases of cord-lesion which can be satisfactorily explained on no other hypothesis than that of concussion; but when we have excluded those cases where the bruising of the cord has been produced by actual crush of displaced vertebræ, by severe and sudden bend of the cord itself, or where the symptoms have been due to the pressure of blood, it is singular how very few remain. And it is well that it should be so, for a new danger would be added to life if an organ of such vast importance in the animal economy as the spinal cord were liable to structural lesion from the same kinds of force as cause concussion-lesion of the brain. A lesion which may be of small size and possibly of small moment in the case of the brain, cannot be otherwise than of great moment, even if only of small size—in the case of an attenuated and slender cord which is the sole medium of communication between distant parts. And happily, as a matter of fact, the spinal cord is very rarely thus injured in the absence of injury to the form and structural integrity of the spinal column.

THE OPERATION OF TREPHINING THE SPINE proposed many years ago, and adopted several times, has made no progress in surgery, nor is it likely to do so. In cases of fracture-dislocation the cord is usually damaged irreparably; and when permanent pressure is exerted on the marrow by displaced bone, exact diagnosis is often impossible, and the physical difficulties of removing or elevating the displaced vertebra—be it remembered the body of a vertebra, and therefore far removed from the surface—would be almost insuperable. And we should add gravely to the dangers of the case by laying open the spinal canal. Here, again, a too ready assumption of analogy between brain and spinal cord led in all probability to this operation, which a clearer understanding of the physical differences in the situation of the two organs would have shown to be little feasible, and less likely to be followed by good results. It is an operation not within the range of practical surgery.

PUNCTURED WOUNDS.—Some of the most formidable injuries with which the surgeon has to contend are punctured wounds in the cervical region. The horizontal direction of the spinous processes in this part of the column renders it comparatively easy to open the spinal canal, to incise the theca vertebralis, or even to wound the cord; but in other regions also the spinal canal may be opened by some sharp instrument, such as the point of a sword, if the force of the blow has been great, and its direction sufficiently oblique. The extent of the injury will be revealed only by the resultant symptoms of nerve-impairment, of more or less paralysis, and possibly also by the escape of cerebro-spinal fluid. While surgically of the gravest moment, these cases are, at the same time, worthy of all study from the light thrown by the symptoms on the physiology of the cord. The danger of meningitis is great, and if the cord has been wounded, there is risk that repair may be imperfect, or that the injury may be the starting-point of secondary degeneration. It is important to cleanse and close the wound, removing any foreign body suspected to be present, and to keep the spine at perfect rest.

Little less serious, because of the difficulty of treatment, are punctured wounds of the large vessels in the posterior part of the neck: the posterior auricular, the arteria princeps cervicis, and the occipital, the vertebral, and profunda cervicis. The record of cases seems to show that ligature of the carotid trunk is usually of little lasting avail for the arrest of hæmorrhage from its branches, owing to the very free cross-anastomoses, while ligature of the first part of the subclavian is likewise impracticable. The surgeon must therefore rely on the less formidable procedure of finding, by careful dissection, the precise vessel which has been wounded, and placing a ligature above and below the bleeding point. This is the line of practice which ought invariably to be followed, if the hæmorrhage is such as to indicate that any large vessel has been wounded. The danger to the patient even of free incision, to find and secure the vessel, is far less than that of repeated hæmorrhages and burrowing of blood throughout the tissues of the neck. After puncture of the vertebral artery, however, it may be no easy matter to put a ligature upon it as it lies within its bony canal, and ordinary pressure upon the surface is likewise of little or no use in arresting the bleeding. It is essential to expose the bleeding point, and here success has attended the practice of careful plugging against the transverse process; and in a recent case the plan was adopted of plugging with antiseptic material which it was possible to leave in the wound long enough to secure complete occlusion of the vessel.

In all these operations it is important to carry out most thorough antiseptic treatment, so as to avoid the risk of spreading suppuration in the deeper parts of the neck. For suppuration itself may lead to opening of some deep vessel, and in a remarkable case, recently under the care of Mr. Banks, of Liverpool, when the patient had nearly perished from loss of blood, that surgeon cleared out a huge mass of putrid blood-clot which filled up the whole posterior part of the neck from mastoid process to clavicle, and applied ligatures with success at the very origin of the occipital artery, just in front of the transverse process of the atlas, where the bleeding point was found. Antiseptic surgery and antiseptic plugging hold out better hope of success than has hitherto often attended the treatment of these very dangerous wounds of the vertebral artery; while the avoidance of after-suppuration goes a long way to render less formidable the requisite operation of free dissection to find the source of hæmorrhage after punctured wounds in the posterior parts of the neck. HERBERT W. PAGE.

BACTERIUM.—An oval or ellipsoidal micro-organism, forming a definite genus in the class of Schizomycetes, viz. the microbacteria of Cohn. As a rule the length is never more than twice the breadth. The term bacterium was formerly used to denote the whole class of Schizomycetes, but it is now restricted to those falling under the above definition.

For general characters, see the article SCHIZOMYCETES.

The bacteria reproduce themselves mainly by fission. There has also been described (Dallinger) a fusion of two individuals (*B. termo*) with the resultant formation of a cyst containing spores, which on liberation develop into adult bacteria.

(1) SAPRIC BACTERIA are two, as known at present, and the first is more important, being supposed to be the agent by means of which putrefaction goes on in animal fluids, resulting in the formation of the alkaloidal substance sepsin, the poison of sapræmia.

B. termo. Usually dumb-bell in shape, perhaps from rapid multiplication. Injection into the tissues or blood of animals produces no effect. It is very active, and provided with a flagellum.

B. lineola. Found in ponds, and forms the common bacterium fungus on boiled potatoes. It is larger than *B. termo.*

(2) The PATHOGENIC BACTERIA are very interesting from their excessive virulence.

B. septicæmiæ (Koch & Davaine) is an oval organism, the protoplasm of which is collected at each end, leaving a central clear space. That observed by Koch was found in septicæmia of birds, being obtained from putrid meat, while Davaine's experiments were carried out in rabbits, the organism being derived from putrid ox-blood. The latter organism exists in the blood to such an extent that a billionth of a drop has proved fatal, and even a trillionth (Davaine).

B. of chicken cholera. The organism of this infectious disease is supposed to be a bacterium. VICTOR HORSLEY.

BALANITIS is an inflammation of the mucous membrane covering the glans penis. It may be the result simply of want of cleanliness, and this is especially the case in young subjects with long foreskins. It is, however, more usually an accompaniment of gonorrhœa, and arises from the extension of the inflammation of the urethra to the surface of the glans penis. A further extension of the disease to the mucous layer of the prepuce constitutes what is called balano-posthitis. The symptoms are itching and swelling both of the glans and the prepuce, which latter sometimes becomes œdematous. There is also a profuse discharge of fetid pus. If the prepuce can be drawn back and the glans exposed, the latter will be found swollen, red, and bathed in fetid discharge. Frequently the epithelium becomes eroded, leaving superficially ulcerated surfaces.

Sometimes crops of herpetic vesicles appear, which run together, forming ulcers which might possibly be mistaken for chancres. In fact, it is necessary to remember that a balanitis may be caused by syphilitic chancrous erosion of the glans. The absence of urethral discharge, the defined ulcer, the induration, and, especially the history as to the period of incubation, will all help towards the formation of a correct diagnosis in such a case. The extension of the inflammation to the prepuce is marked by a still further swelling of that part, caused by effusion into the cellular tissue between its two surfaces; the result being complete inability to retract the prepuce, constituting a phimosis.

It is in conditions like this that some difficulty arises in making a right diagnosis as to whether the patient is suffering from gonorrhœa or syphilis. The absence of any history of a sore, the failure to detect any indurated or painful spot beneath the prepuce, the unmixed purulent discharge, the scalding on passing water, and the presence of chordee, are all symptoms leading to the conclusion that the case is one of balanitis arising from the infection of a gonorrhœa. On the other hand, the history of the presence of a sore, and the detection of a painful and indurated spot beneath the prepuce, the admixture of blood with the discharge, the enlargement of the inguinal glands, and the absence of scalding and chordee, would all point to the presence of a chancre beneath the inflamed prepuce. When the prepuce is short and the orifice small, a paraphimosis is occasionally formed by the prepuce slipping back behind the corona, the swollen condition of the glans rendering it impossible to replace it at the moment. The contracted preputial orifice acts as a tight constricting band, causing considerable swelling and œdema of the surrounding parts. The pain is sometimes excruciating, and unless relief is soon afforded, ulceration, or even sloughing, of the parts may take place.

The *treatment* of balanitis varies with the intensity of the disease and the complications which require to be met. When it arises in a young subject, from the collection of secretion beneath a long prepuce, simple attention to cleanliness will go far to effect a cure. The prepuce should be drawn back twice or three times a day, and the parts thoroughly washed with tepid water and dried. They should then be dusted over with a powder consisting of equal parts of starch and boracic acid, and the prepuce replaced. In the event of a recurrence of the disease, circumcision should be performed as soon as the discharge has been arrested. It is well known that amongst the Jewish community the rite of circumcision confers immunity from this disease. When, however, balanitis arises as a consequence of venereal disease, more active measures are needful.

In addition to the ordinary treatment of gonorrhœa, if the inflammation is confined to the glans, it will often suffice simply to cleanse the parts three or four times a day, and keep them dusted over with the starch and boracic acid powder, or the simple insertion of dry lint between the glans and the prepuce, frequently changed, will sometimes effect a cure. If the disease has extended to the prepuce with much swelling of the parts, hot fomentations and an occasional warm hip bath will be found useful. The application of nitrate of silver, either by passing a solid stick underneath the prepuce, round the glans, or else by injecting a solution (gr. 40–f℥j.) is useful, followed by the constant use of a lead and opium lotion, applied externally on lint and injected underneath the prepuce. As soon as the prepuce can be withdrawn, if the surface of the glans is found to be eroded, one of the best applications is the oleate of zinc spread thickly on lint on both sides, and inserted between the glans and the prepuce. If phimosis is established it can seldom be needful to resort to operative measures for its relief during the acute condition. Hot fomentations, soothing injections, rest in bed, and keeping the penis in an elevated position, will be useful.

Should it, however, be needful to expose the glans, the prepuce should be slit up on its dorsal surface, but the completion of the operation should be deferred until a later period. When paraphimosis exists, means should at once be taken to effect its reduction. *See* PARAPHIMOSIS.

PAUL SWAIN.

BANDAGES are usually made of unbleached calico, but in special cases and for special purposes a variety of materials are used, the chief of which are washed calico, linen, flannel, lint, muslin, gauze, elastic webbing, and india-rubber.

Whatever material is used it should be sufficiently firm and strong to effect the object for which the bandage is applied, and at the same time be supple enough to be evenly adapted to the inequalities of the limb. If the bandage is to be applied wet, washed calico should be used; when warmth combined with some amount of elasticity is required, flannel is very useful; whilst, if elasticity is the property mainly desired, elastic webbing or Martin's india-rubber bandages are the best materials; if lightness and open meshes into which plaster of Paris may be rubbed are required, nothing is better than the kind of muslin known as crinoline.

Bandages are classified as 1. *Simple*; 2. *Compound*. A simple bandage consists of a continuous piece of material wound up into a roller, and hence called a *roller* bandage.

A compound bandage is more complex, and requires more than one continuous piece for its formation; the four-tailed, the many-tailed, the T-bandage, and the suspensory bandage, are compound bandages.

The *Roller* bandage is made by tearing the material used into strips, varying in width from three-quarters of an inch to six inches, and in length from two to ten yards, according to the part of the body for which it is required; for the fingers it should be three-quarters of an inch wide, and a yard and a half long; for the upper limb and head from two to two and a half inches wide, and six yards long; for the lower limb two and a half to three inches wide, and six or eight yards long; for the body four to six inches wide, and ten yards long.

No selvage should be included in the bandage, as it would be liable to cause uneven and painful pressure.

Bandages should be tightly and evenly rolled. If a bandage be rolled up from one end only it is called a *single-headed* roller, whilst if from both ends it is called a *double-headed* roller. A roller bandage is said to have two extremities, a head, body, and two surfaces; the free end is called the *initial extremity*, and that in the centre of the roller the *terminal extremity*, whilst the intervening portion is the *body*; so much of the bandage as is at any time rolled up is known as the *head*; the two surfaces are inner and outer.

When applying a bandage, the surgeon should stand in front of the part to be bandaged, and, if a limb, he should take care to place it in the position it is intended to occupy, for a subsequent alteration of it not only disarranges the bandage, but renders it liable to constrict the limb. He should hold the roller in the right hand if the left limbs are to be bandaged, and *vice versâ*, and then, placing the initial extremity on the front of the limb, he should fix it by a circular turn, so placed that the bandage is laid on from the inner to the outer side as it passes over the anterior surface of the limb.

To remove a bandage, the terminal extremity should be taken up by one hand and passed behind the limb to the other, and by this back again in front, the folds of the bandage being gathered together into a bundle as they are transferred from one hand to the other; by a quick succession of these movements the bandage will be rapidly and tidily unwound, and will not be twisted upon itself.

In applying a simple bandage to any part, one or other of the following methods, either alone or in combination, will be used. They are named according to the arrangement of the turns of the bandage.

The *Circular* bandage consists of a number of turns arranged so that each accurately covers the preceding one; it is used to keep dressings on the forehead, the sides or back of the scalp, or the neck, and to retain pads on particular points.

The *Oblique* bandage is applied by allowing the roller to follow its own course smoothly up the limb; the result of this is that parts are left uncovered between the turns of the bandage. It is used to retain dressings, such as fomentations, which require frequent changing, and is of special value in the application of the earlier layers of plaster or other immovable bandages, where a number of layers are used, for in that case all the intervals may be subsequently covered in; and there are the advantages that the bandage lies quite smoothly without reverses, and also that the fibres run more nearly longitudinally and so afford extra strength, and obviate the tendency to transverse cracking, which is so liable to occur when the bandage is applied spirally.

The *Spiral* bandage is, as its name implies, wound spirally round the limb; each circle of the spiral should overlap the preceding one by about one-third of its width; it is only applicable to regions where the size keeps the same or but slightly increases, as the fingers, just above the wrist and ankle, the upper arm, or the chest.

The *Spiral* bandage *with Reverses:* when the spiral bandage is applied to a part whose circumference rapidly increases in size, the roller will, if laid on evenly, soon run upwards obliquely and leave an interval between two successive turns; in such cases it is necessary to bring the bandage down to the proper level by what is called *reversing*, or so turning it on itself that what was before the upper border becomes the lower, and the inner surface the outer. To reverse the bandage the roller should be unwound for two or three inches beyond the place where the reverse is to be made, and the part of the bandage which is already applied should be drawn firmly to the limb, and, in the case of a left limb, the left thumb placed on the lower border of the bandage at the required situation. With the head of the bandage held loosely by the right hand in the supine position, a movement of pronation will fold over the upper border so as to make it the lower one, and then the roller can be carried onwards evenly round the limb, overlapping one-third of the previous turn, until it reaches a point in a line with the previous reverse, where the whole proceeding should be repeated. Before removing the thumb which fixes the lower border of the bandage, the roller should be drawn tight, in order to make the reverse lie smoothly and prevent wrinkling of the bandage. The reverses should be made to fall in one line along the limb, and should be so situated as to avoid bony prominences. This method of bandaging is chiefly used for the forearm and leg, and should not be used for other regions if the simple spiral bandage will do.

The *Figure-of-eight* bandage is another method of bringing the bandage down when it is advancing too rapidly up the limb; but it is more especially adapted to covering joints such as the ankle, knee, wrist, and elbow: it consists of two circles joined together like a figure of eight, one of them being above the joint and the other below, whilst the crossings are made to fall in one line along the front or outer side of the joint. Though chiefly used for joints, it is applicable to all parts of limbs; but it has, in the latter cases, the disadvantage that the lower border of the upper circle does not lie evenly against the limb, and it is only by the gradual ascent of the lower circles that a tidy, even covering is obtained.

The application of the above methods of bandaging to individual parts is hardly called for in a work of this nature, but some of the more useful special bandages will be described.

The *Halter* bandage is useful for retaining dressings on the chin, vertex of the head, and nape of the neck. Place the initial extremity of a single-headed roller, two inches wide, on the vertex of the head, and carry the roller down the side of the face just in front of the ear, beneath the chin and along the opposite side of the face to the vertex, where it will cross the initial extremity at an acute angle. Then direct it obliquely backwards, in front of and below the parietal eminence, to the nape of the neck, and thence horizontally round the front of the chin and onwards to the nape of the neck again, where its direction must be changed so that it passes below and in front of the parietal eminence of the other side to the vertex, where the terminal end may be pinned; or, if required, the whole series of turns may be repeated.

The *Knotted* bandage is used for making pressure on the temporal artery. Put a pad or graduated compress on the bleeding point, and then, standing on the opposite side of the patient, take a double-headed roller and apply the portion of bandage intervening between the two heads over the compress, and carry each roll circularly round the head until they reach the compress again. Then, if it be the left temporal artery that is to be compressed, the roll coming round the front of the head should be taken in the right hand and turned round the lower border of the other one, and carried upwards with its outer surface applied to the scalp, whilst that now in the left hand should be passed downwards beneath the chin with its inner surface applied to the face. Each roll must be carried round the head, and, meeting again at the injured temple, a second ‘knot’ should be made, and the ends of the bandage directed horizontally to the opposite side of the head and pinned. The first ‘knot’ should lie over the compress, and the second accurately over the first, so that their full pressure may be gained.

The *Capelline*, or recurrent bandage of the head is useful for making pressure or retaining dressings on the scalp, and a modification of it is used for bandaging stumps. For the scalp a double-headed roller, two inches wide and six yards long, with one head about a third larger than the other, is required. The operator should stand behind the patient with the larger head in his right hand, and the smaller in his left, and the intervening portion should be placed as low down on the forehead as possible, so that any tendency to upward displacement may be prevented by the frontal protuberances. Both heads of the roller are then carried backwards to the nape of the neck, where the smaller one is taken in the right hand, twisted round the lower border of the other, and directed vertically over the scalp to the root of the nose, whilst the larger is continued horizontally round the head to fix the vertical one in front; after which the latter is carried backwards again to the occiput, a little to one side of the first turn and slightly overlapping it, and is fixed by the continuation of the horizontal turn. Similarly, the smaller head of the roller is carried backwards and forwards over the scalp, first on one side of the middle line and then on the other, until the whole of it is covered in. The horizontal portion must always cross the other superficially, so as to fix it, preparatory to its being turned back again. Finally both heads of the roller will be running nearly horizontally. They should be looped together at the occiput and carried forwards to the forehead, where the ends may be tied or pinned together.

For a *Stump* a single-headed roller will suffice. Take a few circular turns round the limb a little above the end of the stump; fix the bandage on the under surface by the fingers of the left hand, and take a longitudinal turn over the face of the stump and fix it on the upper surface by the left thumb. Repeat the longitudinal turns first on one side of the middle line and then on the other, fixing each as before, until the whole stump is covered in; and finish off by a few circular turns so as to fix the longitudinal ones in their proper places.

The *Spica* bandage is named from its fancied resemblance to a spike of barley: it is essentially a figure-of-eight bandage, one loop of which is larger than the other. It is used for the shoulder, thumb, and groin.

For the shoulder a roller bandage, two and a half inches wide and seven yards long, will be required. Protect the folds of the axilla with cotton wool, and fix the bandage by a few circular turns round the upper arm; carry the roller round the back of the chest and the opposite axilla to the front, and onwards till it crosses the commencement of the same turn on the outer side of the arm, and then direct it beneath the axilla to the front again, and a second time carry it over the shoulder and round the chest and axilla as before. The whole series of turns must be repeated till the shoulder is covered; and as they intersect on the outer side of the arm and shoulder, they should overlap one another by about one-third of their width.

When the turns of the bandage are placed successively higher and higher on the shoulder, as above described, the spica is called *ascending*, but if the first turn is made over the shoulder at the root of the neck and succeeding ones lower and lower, it is termed *descending.*

The spica for the groin is used to make pressure over the abdominal and femoral rings as a temporary support to herniæ, and to retain dressings on any part of the inguinal regions. Take a roller three inches wide and seven yards long, and fix the initial extremity by a circular turn round the upper part of the thigh, passing from the inner to the outer side in the usual way, and then carry the roller round the pelvis between the great trochanter and the crest of the ilium on each side, and next obliquely across the lower part of the abdomen to the front of the thigh, where it will cross the commencement of the same turn, and thence direct it round the thigh and forwards between its inner surface and the scrotum. Repeat the figure-of-eight loops round the thigh and pelvis as often as necessary, and make each turn overlap the preceding one on the thigh by about half its width. It is usual to place the first turn over the lower part of the groin, and the subsequent ones successively higher and higher (*ascending spica*), but they may be laid on from above downwards (*descending spica*).

To bandage both groins, commence with a circular turn round the pelvis, and then direct the roller across the lower part of the abdomen to the left thigh; take a loop round this and continue the bandage round the back of the pelvis to the right thigh, and, after encircling that, carry the roller across the lower part of the abdomen and round the entire pelvis to the left thigh. The turns round the thighs are made alternately and pass from the inner to the outer side on the front of the left one, and from the outer to the inner on the right; when the bandage is completed, there will be, in addition to the intersections on the thighs, a third series of them over the middle line of the abdomen.

The spica for the thumb requires no further description than that it consists of figure-of-eight loops, placed alternately round the wrist and the ball of the thumb until the latter is sufficiently covered.

T-bandages, either single or double, have the shape indicated by their name, the former having only one vertical piece, whilst the latter has two, which are attached, at a short distance apart, to the horizontal limb: they are chiefly used for retaining dressings on the perineum and the parts about, but may be used for the scalp, chest, &c. For the perineum the horizontal portion is fixed round the body just above the iliac crests, and the vertical one made to lie over the mid-sacral region. For the female the vertical portion is undivided and is brought forwards between the legs, over the vulva, and fixed to the front of the horizontal segment; for the male it is split along the middle for a sufficient distance to allow of the ends being brought forward on each side of the scrotum. For the scalp the horizontal portion is fixed circularly round the forehead and occiput, and the vertical one carried backwards, from the former point, over the vertex and fixed to the horizontal portion behind. For the chest the horizontal segment of the double bandage is fixed round the body, and a vertical portion brought forwards over each shoulder, and fastened in front.

The Many-tailed bandage, or bandage of Scultetus, is used where it is wished to combine even support with ease of removal; it is most commonly used for the chest and abdomen. A sufficient number of transverse strips of calico or flannel are arranged parallel to and overlapping one another by about one-third of their width, and fixed so by being stitched along the middle to another strip at right angles to them. To apply it, the connecting piece of the bandage should be placed in the middle line behind, and the transverse pieces brought round the body or limb successively and crossed in front. To prevent the bandage slipping when applied to the chest or abdomen, two strips should be attached to the upper end of the connecting piece, and brought over the shoulders like braces and attached in front.

The 4-tailed bandage consists of a piece of calico split from either end to within a few inches from the middle; it is mainly used for the lower jaw, but is also applicable to the knee and the vertex of the head. For the jaw it should be about four inches wide and fourteen long, with a hole or slit made near one edge of the bandage in the middle to receive the chin, and be split to within two inches of the centre. Put the smaller segment over the lip and fix the tails corresponding with it below the occiput; carry the other ones upwards in front of the ears and fasten them on the vertex; the two pairs should be attached to one another along the middle line of the vertex, so as to prevent their slipping. For the vertex, take a broader bandage with tails of equal width, and place the undivided portion on the top of the head; direct the anterior pair of tails backwards and tie them below the occiput, and the posterior ones forward and tie beneath the chin; for the knee, place the undivided portion over the patella, cross the tails of the bandage behind the knee, and tie the lower ones in front of the lower part of the thigh, and the upper ones in front of the tubercle of the tibia.

The triangular bandage, or the Esmarch bandage, is made by cutting a piece of calico, about forty inches square, diagonally into two halves; of the three borders, the longer is called the lower and the others the side borders; of the three angles that opposite the lower border is called the point and the others the ends. Though of much use as a temporary bandage, on account of its wide applicability, it is not much used in civil surgery, and so calls for but little mention here. To make a small sling, i.e. for the hand and wrist, with a triangular bandage fold it lengthwise twice, throw one end over the shoulder of the injured side, and bring the other one round the front of the wrist and over the sound shoulder and knot it to its fellow. To make the larger sling, i.e. for the whole forearm, place the unfolded bandage on the chest with the point of it towards the elbow, and one end thrown over the sound shoulder; next bend the elbow and bring the forearm to the chest against the middle of the bandage, and support it in that position by carrying the other end of the bandage over the shoulder of the injured side and tying it to its fellow. Finally fold the point of the bandage round the elbow and upper arm, and pin it in front. To make the shawl-cap for the scalp, fold the lower border of the bandage and place it on the forehead with the point hanging down to the nape of the neck; next carry the ends round the head, crossing them behind, and tie them together on the forehead, and finally turn up the point and pin it to the body of the bandage above.

The triangular bandage is also used to retain dressings on the breast and on the gluteal region, and as an improvised suspensory bandage. Bilton Pollard.

BARBADOES LEG. *See* Elephantiasis Arabum.

BATTEY'S OPERATION. *See* Oöphorectomy.

BAVARIAN SPLINT. *See* Immovable Bandages.

BEDSORES.—Whenever prolonged and continuous pressure is maintained on a part there is much danger of gangrene occurring; the pressure impedes or completely arrests the circulation, and if continuously maintained for a sufficient time, death of the affected part will occur from that cause alone. But if the pressure be not prolonged to this degree, the tissues and vessels will be so injured that, on the re-establishment of the circulation, inflammation which may terminate in gangrene will occur, and especially will this happen in old and enfeebled persons and those whose constitutional powers are lowered by fever. In addition to simple pressure there are other potent agents in the causation of bedsores, such as the irritation of urine, fæces, the secretion of the skin itself, creases in the bedclothes, crumbs of bread, &c. Many of these causes are liable to come into greater prominence in some cases, such as fractures of the spine, in which the lower part of the body is paralysed and in which the urine and fæces are passed involuntarily.

In certain injuries of the nervous system bedsores appear very rapidly, and that too when the greatest care is taken to prevent injurious pressure and irritation of discharges; these bedsores are described by Charcot as 'acute'; they may appear within a very few days or even hours after the injury. In surgical practice they are mostly met with after spinal injuries, though they may occur after injuries to the brain; in the latter case they are situated on the upper and inner part of the buttock of the paralysed side, whilst in the former they are situated in the mid-sacral region just above and to the inner side of the cerebral one; the spinal bedsore usually begins on the fourth or fifth day. Acute bedsores are considered by Charcot to result from a lesion of trophic nerves, and by others to be due to vaso-motor paralysis; they are, however, of comparatively rare occurrence.

The simple pressure sores are met with in the regions most pressed upon during prolonged confinement to bed, viz. over the sacrum and trochanters, but they may occur over the elbows, scapulæ, and on the heels, &c.; and sores identical in nature and known as 'splint-sores' may be met with over any of the bony prominences, due to the pressure of splints. The skin first inflames, and if the cause persist, vesication follows; the cutis next loses its vitality and an eschar or superficial cutaneous slough succeeds; this is slowly detached from the surrounding healthy skin, leaving a more or less deep excavated ulcer of unhealthy aspect, and sometimes exposing a portion of carious bone or even opening up the spinal canal and giving rise to septic meningitis.

Treatment.—This should be mainly preventive, and in the hands of the nurse; all sources of irritation should be scrupulously avoided; too continuous pressure on any one region should be prevented by changing the position of the patient where this is possible, and where not it should be evenly distributed and moderated by water-beds, ring-pillows, &c. The parts pressed upon should be systematically washed night and morning, and rubbed with some stimulating and astringent lotion such as spirits of wine, or a solution of bichloride of mercury in proof spirit (2 grains to the ounce). In the erythematous stage the part may be painted over with collodion, with one of the lotions mentioned above, or with a solution of nitrate of silver (10 grains to the ounce). When sloughs have formed, their separation may be hastened by poultices or fomentations, and after their detachment, if stimulants seem indicated, equal parts of resin ointment and balsam of Peru may be applied, and when the sore begins to fill up and look healthy it may be treated as a simple ulcer, provided always that pressure be reduced to a minimum.

Bilton Pollard.

BELLOCQ'S SOUND is an instrument devised to assist in the operation of plugging the posterior nares. It consists of a curved canula, shaped like, but of larger size than, a Eustachian catheter. This contains a stilette terminating in a piece of watch-spring, at the extremity of which is an eyelet for carrying a thread. The canula being passed along the floor of the nose, the watch-spring is made to protrude into the mouth by means of the stilette, and the thread can thus be readily caught and employed to draw a piece of whipcord through the nostril, to which a suitable plug is attached.

BISTOURY.—A French term which has been adopted by English surgeons. There are several varieties of bistoury—viz. straight and curved, sharp and probe-pointed. The straight, sharp-pointed bistoury is useful in amputating fingers, the curved in opening abscesses; the probe-pointed instruments are useful in dividing fistulæ and the stricture in hernia.

BITES OF VENOMOUS INSECTS AND REPTILES. *See* STINGS OF INSECTS.

BLADDER, Diseases of the.—ATONY OF THE BLADDER.—*Loss of Contractile Power of the Muscular Coat.*—This affection is induced in various ways; most frequently by moderate obstruction to the outflow of urine, a difficulty not sufficient to cause hypertrophy of the muscular coat. Probably a constant factor, as a predisposing cause, is a tendency to degeneration of the muscular tissue; certainly it is very frequently present in these cases. Indeed, it is not otherwise clear why obstruction should cause muscular hypertrophy in one individual and atrophy in another. This affection is often miscalled 'paralysis'; but it is quite distinct from true paralysis, consequent on disease or injury of the nervous centres. In paralysis the urine stagnates in the bladder through want of nervous stimulation of the muscular coat, not from impediment to its escape.

The *causes* of atony are: urethral stricture; prostatic hypertrophy or enlargement at the neck of the bladder; stone or tumour in the bladder; habitual fæcal distension of the rectum; repeated delays in emptying the charged bladder; sudden retention caused by gonorrhœal inflammation and swelling of the neck of the bladder.

Two forms of *stricture* cause habitual partial retention. One exists as a membranous band passing across the lumen of the urethra, near the meatus urinarius. Such a band, by exciting reflex spasm of the perineal muscles, causes habitual partial retention of urine. When more deeply placed, i.e. in the bulbous portion of the canal, the stricture has longer extent, and consists of induration of the submucous tissue. Such a contraction need not greatly diminish the size of the stream, and its existence may therefore not be suspected. *Prostatic hypertrophy*, chiefly affecting the middle lobe, in certain elderly men, may develop sufficiently to hinder the outflow also without materially lessening the size of the stream, though its force is weakened. Not only tumours produced by overgrowth of the prostate, but also those which form in the walls of the bladder, especially if placed near the floor, interfere with the proper contraction of the organ, and may give rise to atony of its coats. *Calculus* excites atony in bladders of which the muscular coat is degenerating, by the frequent calls to void urine it excites exhausting the contractile force. When atony or sluggish contraction is due to *distension of the rectum* and colon, the nutrition of the muscular tissue of the viscera generally is bad, and with the bladder thus predisposed to inertia, the mechanical impediment determines the distension. In women with the same predisposition, the gravid uterus sometimes causes atony. When this has happened, the bladder remains lax, and gets more and more distended, until a considerable abdominal tumour is formed.

Again, atony arises from neglect of the calls to micturate, either from hysterical perversity, or because some urethral affection makes the act painful, as in women who have a vascular tumour of the urethra. It is met with also in lethargic persons, with minds absorbed in mental occupation, who delay to empty the bladder, and so train it to over-distension. In this way the bladder may attain enormous dimensions. In one instance the writer drew off seven and a half pints from a bladder which reached to the epigastrium, and had been mistaken by the homœopath in attendance for a visceral cancer. Atony in young men occasionally follows what is called gonorrhœal retention: that is, the complete closure of the bladder by inflammatory swelling of the neck. Besides atony, this very painful affection may leave behind it, as sequelæ of the diminished evacuating power, cystitis, or interstitial nephritis, and thus gravely affect the patient's health.

The *symptoms* that attract the patient's attention to his condition are usually a slight discomfort and imperfection in voiding urine. The stream is a little delayed, wants force, and the terminal ejection is imperfect. Also, if the patient neglect the call to micturate, he finds the power somewhat impaired when he does begin. There is also some irritability of the bladder. Urine is voided more often than formerly. Sometimes a little pain is felt deeply in the perineum and the call to micturate is more imperative than in health. Or, the first symptom noticed may be involuntary discharge of small quantities of urine when the patient coughs or laughs—an occurrence that is generally attributed to loss of power to retain urine, not to the overflow of a really distended bladder. When stricture is the cause, the patient may have noticed a little whitish discharge from the urethra. With enlarged prostate, the patient is mainly annoyed by the necessity for rising at night to pass water, by the inconveniently frequent calls to micturate in the morning, and by troublesome oozing of urine into his dress. He generally complains that the stream will not come at once; he has to wait and strain a little. When stone or vesical tumour is concerned in the imperfect contraction, the symptoms of these affections usually overshadow those of simple distension.

When the overcharge has lasted a long time, or has followed gonorrhœa, catarrh or chronic cystitis begins. The urine becomes turbid, has a faint disagreeable odour, is often neutral or alkaline, and when time has allowed the mucus to subside, an opaque white deposit collects. If the affection has lasted several months, the urine may be ammoniacal or fetid, dark and very turbid, or even ropy, from a copious secretion of muco-pus. When this condition is present, the discomfort of the patient reaches absolute pain and distress. But in a considerable number of cases the condition has been so gradually produced, and the sufferings refer so vaguely to the bladder, from which, without ever quite emptying it, the patient expels with little difficulty about the usual amount of urine, that he often attributes his discomfort to troubled digestion, made irritable, partly through pressure and displacement of the viscera by the overfilled bladder, partly by their sympathetic disturbance. It is in such cases that the affection is often overlooked, or diagnosed as ascites or visceral tumour. When the patient is examined, the following conditions are discovered. In ordinary cases the distension of the bladder does not present a tumour obviously rising above the pubes, and the suspicion of atony is only proved to be correct by examination of the bladder. A bladder which has been gradually expanded during months or years through increasing relaxation of the walls, forms a tumour in the middle line that extends upwards from the pelvis towards or even into the epigastrium, or one of the hypochondriac regions. But even when the organ is so much distended as to invade the abdomen, the swelling does not resemble that of the healthy bladder when full. The swelling is ill-defined, and fluctuates readily on palpation. This character, combined with the unexpected height to which the tumour has mounted, often misleads the physician.

The existence of an imperfect evacuation of the bladder is ascertained by directing the patient to void urine; and then, having placed him in the horizontal position, if the collection of urine is large, by passing a catheter to draw off and measure the residue. As the urine escapes through the catheter, the want of contractile force will be shown by the stream subsiding to a dribble or stopping altogether, unless the bladder be artificially compressed by the hand on the abdomen, or by the patient's coughing or straining. The state of the urethra may be examined by passing a bullet bougie (No. 25 French scale) along the penile urethra to the bulb. Should a membranous contraction exist near the meatus, the passage of the bougie will be arrested, and the amount of the narrowing can be gauged by a smaller bougie. To detect stricture beyond the penile portion, the stem of the bougie must be bent that it may pass under the pubic arch, or an ordinary bougie of the same size may be used instead. This latter instrument will reveal stricture at the bulb, and by the way it stops at the neck or enters the bladder, will often indicate a prostatic enlargement. The diagnosis of atony arising from neglect or other non-obstructive cause is founded on the absence of obstruction, and by the presence of the signs appropriate to those causes.

Pathology.—Habitual retention favours attenuation of the coats of the viscus; the muscular fibres are small and pale; their contractile power is diminished, and in time is lost; the ureters and the pelves of the kidneys become dilated, and the pyramidal and cortical portions wasted or absorbed. Thus the secretive power of the glands is much lessened; and the consequences of imperfect depuration of the blood follow. The mucous membrane of the bladder and ureters and pelves becomes congested and inflamed. This slight chronic irritation is apt to become acute, and to cause fatal nephritis when the urine is withdrawn by catheter in cases of advanced degeneration of the kidneys. Under acute inflammation, the mucous membrane of the bladder grows dark red, or slaty, is marked by ulcers or shreddy patches of adherent pus, and the atrophied kidneys are destroyed by suppurative nephritis. In many cases, of course, the evidence of the disease which has occasioned the atony will be present in addition to those of the atony itself.

The *treatment* consists in attacking and removing the cause, or if that be not possible, in palliating its effects. If stricture be present, it must be widened until No. 20 of the French scale can be passed easily through it; meanwhile the bladder must be regularly emptied twice daily, or more frequently according to the amount of distension, to assist the contraction of the muscular coat by removing the strain. In simple cases the bladder often regains good tonicity and complete power of evacuation. The patient must be trained to pass the catheter himself once in twenty-four hours to ensure the complete evacuation of the urine, and to wash out the bladder through the catheter so long as mucus renders the urine turbid.

If these precautions are neglected, the evil will reappear. When no grave renal or vesical disease exists, the urine quickly recovers its normal acidity and clearness, and the bladder most of its tonicity.

When the atony has been slowly developed, and the expansion of the bladder has become very great, it is necessary to take precautions in the evacuation. The patient should lie down, and a body roller be applied, that as the urine escapes the pressure on the abdominal organs may be maintained, by drawing together the wrappings of the band. The whole quantity should not be removed at one sitting. When the bladder is so far relieved that it sinks into the pelvis, the rest of the urine may be left till next day and then withdrawn. If the urine is turbid, the bladder should be washed out with 6–8 ounces of cold water, containing one part in eighty of carbolic acid. The catheter should be carefully oiled before it is used, with weak carbolic oil, to prevent the introduction of septic agents. A common result after the abstraction of large collections of urine, is subacute cystitis, pyelitis, and fatal nephritis, due, it is believed, to the sudden removal of pressure from the kidney, and to the introduction of sepsis by the use of unpurified instruments. The catheter should always be withdrawn on each evacuation, until several days have elapsed. When the viscera have become accustomed to the absence of pressure from retained urine, and the urethra to the passage of the catheter, that instrument may be tied in, and the bladder kept constantly empty by continuous drainage through an india-rubber tube into a vessel under the patient's bed. The end of the tube should be submerged in carbolic water, as an antiseptic precaution. This rest to the coats of the bladder is a valuable restorative of the tonicity of the organ, and also useful for extinguishing chronic cystitis or vesical catarrh, should that be present. Contraction may be quickened by injecting three ounces of cold water (50° F.) into the bladder once or twice daily, according to the effect produced every time the urine is drawn off. Adjuvants to the cold water injection of the bladder, or its continuous drainage, are douches on the sacrum and pubes; small doses of copaiba, oil of sandal wood, &c. Most important aids are regular evacuation of the bowels, and also improvement of the patient's general health by tonics, sufficient exercise, and regularity of *régime* and diet in every particular. If practicable, warm sulphur baths and residence in a mild winter climate should be enjoined. By these aids to the regular evacuation of the bladder, the progress of renal disease is impeded, and life is prolonged and rendered enjoyable even when the tonic power of the organ is not thoroughly restored.

INFLAMMATION OF THE BLADDER.—*Cystitis, Acute and Chronic; Catarrh.*—Cystitis (inflammation of the mucous membrane of the bladder) has two forms—the chronic and the acute; the former being far more frequently met with than the latter. Usually the term 'catarrh' is limited to the chronic form, but not always so. In both forms inflammation of the bladder is a consequence of disease elsewhere, being, probably, never a primary affection. In the great majority of cases the affection is due to incomplete evacuation of urine, but many other causes may produce cystitis.

The obstructive causes are described under Atony of the Bladder, and need be only recapitulated here. They comprise stricture of the urethra; permanent enlargement or swelling and irritability of the prostate and vesiculæ seminales; gonorrhœal inflammation of the mucous membrane of the neck; stone or other foreign body; or tubercular disease or tumour. Special to women, as obstructive causes, are the pressure of the gravid uterus or of prolonged parturition, the irritation of a vascular growth in the urethra, or neglect to empty the bladder.

Among less frequent non-obstructive causes are—stone in the kidney; excessive coitus in elderly men; hæmorrhage and loaded rectum. Cessation of the catamenia sometimes excites cystitis. In weakly children of both sexes, but more frequently in scrofulous or rickety girls, cystitis occurs occasionally without any apparent obstruction to evacuation. Surgical processes, such as the passing or tying-in of catheters, sounding, the operations of lithotomy or of lithotrity, or for the removal of vesical tumours, will excite cystitis. Again, cantharides and, possibly, certain general conditions—such as the gouty diathesis, the debility accompanying typhoid fever or other visceral inflammations—are set down as causes of cystitis.

The chronic form is kindled generally by causes which, of slight effect at first, increase in severity with time. Acute cystitis is the result of sudden or of violent injury; the more dangerous form being that which follows severe operations on the bladder, or the acute congestion of an hypertrophied prostate. The less grave one is that which spreads from the prostatic urethra to the neck and floor of the bladder, but seldom extends over the whole surface of the mucous membrane. So, also, it is acute cystitis which sometimes occurs during the progress of other acute visceral inflammations, or from absorption of cantharides, or after operation on the rectum.

Pathology.—In the common chronic form, the mucous membrane of the floor of the bladder is swollen and uneven, being somewhat mammillated and softened. The colour is red in patches, from capillary engorgement. In long-standing cases, the small veins show as arborescent injection. This increased vascularity affects a larger surface the more the inflammation approaches acuteness. The patches are not evenly coloured; the little projections of the mucous surface being dull red, while the depressions may be of normal tint or even paler than natural. When the affection has lasted some time, the mucous membrane is hardened as well as thickened, but unevenly; some parts are more firm than others, and the red colour is replaced by ashy-grey patches scattered over a generally bluish-grey surface. To these ashy patches adhere layers of viscid exudation, dotted with small concretions of phosphate of lime. Again, in cases of long continuance, the mucous membrane is depressed into pouches where the adherent patches are thicker and more loaded with phosphates. After the inflammation has long continued in the bladder, the lining membrane of the ureters may undergo similar changes throughout their length, though it is usual for only the pelves and calyces of the kidneys (one or both) to be attacked. The pyramids and cortical tissue of the kidneys are also affected with interstitial nephritis and the changes of structure that follow that affection.

In the violent, acute form of cystitis, the bladder surface is very uneven, and of dark crimson colour throughout, approaching to black in the lower portions. The mucous membrane is much softened and destroyed in small areas; the muscular fibres may be exposed, or even perforated to the peritoneal cavity, allowing escape of urine and peritonitis. Whether the cavity be contracted by hypertrophy of the muscular coat, or simply dilated by yielding of the walls to the habitually excessive collection of urine, the inflammatory changes of the organ are not thereby affected.

The contents of the bladder after death vary in character with the amount of inflammation; in the limited chronic form it has a faint but peculiar odour, and is more or less turbid, with a purulent sediment in the *bas fond.* In cases of long standing, where the mucous membrane is indurated, the urine has a most nauseous odour, and contains plentiful flocculent mucous and phosphatic concretions, varying in size from a pin's head to a large pebble.

Symptoms.—In the early stages of the chronic form the symptoms are often too slight to excite the patient's attention, and consist in more frequent calls to evacuate urine that is turbid with muco-pus, and most so at the end of the flow. It is still acid or neutral, and not increased in quantity. If the urine is allowed to stand for a few hours, a light, opaque, white deposit forms of mucus and pus cells. The amount of muco-pus secreted increases greatly with the duration of the disease. It may remain long purulent and not streaky; but usually it becomes viscid, ropy, and of a greenish-yellow tint, settling with a dense deposit which adheres closely to the sides of the vessel which holds it. In this state the urine has a peculiar nauseous odour characteristic of cystitis. After the affection has lasted a few weeks the urine is often bright red from admixture of blood that has oozed from the congested blood-vessels. When the highly acute form is present, the urine is scanty in quantity, though the urgency for micturition is great; probably the diminished quantity is due to extension of the inflammation to the kidneys. The muco-pus is also less, though the urine is darkly coloured by extravasated blood. Though *pain* is at first absent, soon some uneasiness is felt after passing urine, for a few minutes, in the perineum and in the hypogastric region just above the pubes. After a while actual pain comes, and micturition, growing very frequent, causes severe smarting, most violent at the end of the act, when a few drops of pus or blood are expelled from the bladder. Sometimes this smarting is due to masses of gelatinous mucus impeding the flow of urine, and thereby increasing the spasmodic endeavours of the bladder to eject its contents. Behind the pubes also aching pain is felt, and a desire to void more urine when the flow has ceased. In very severe cases, when the bladder cannot get rid of all its contents, the aching pain may radiate to the groins, the insides of the thighs, and to the abdomen or loins. The bladder is tender to pressure of the finger in the rectum or above the pubes, and the organ can often be felt as a tumour lying behind the pubes. If there be partial distension from obstruction, these symptoms are increased.

The *constitutional disturbance* in the chronic form is nil, or amounts only to a sense of discomfort or uneasiness.

The *course and termination* in the chronic form depends greatly on the cause; when arising from moderate obstruction, the increase in severity is very slow. The removal of the cause, when that is possible, usually cures the disease, and it is said that both the chronic and acute varieties may subside spontaneously. At any time the acute form may be superadded, and the case then proceed rapidly and steadily to a fatal termination. The acute form arising from injury to the bladder is of short continuance. The constitutional disturbance is great. The temperature rises to 103° or 104° F., perhaps with a premonitory shiver, and is followed by tremulous pulse, restlessness, thirst, dry tongue, hiccough or vomiting, great prostration, and, if relief is not afforded, death in from four to twelve days. The severity of the sufferings depends greatly on the amount of obstruction that exists to the escape of urine. Should acute cystitis supervene upon a hæmorrhagic congestion from an hypertrophied prostate, the agony is excruciating and unceasing, and quickly exhausts the patient's strength. In most cases death results from implication of the kidneys in the inflammation, and their ultimate destruction. Less often the end is reached through peritonitis or septic blood-poisoning.

The *diagnosis* depends on the presence of increased frequency of micturition; of pain felt during and just after the act; of suprapubic pain or tenderness; of the mixture of pus and blood in the urine. Especially characteristic is the ejection of pus or blood at the end of micturition.

The *prognosis* depends on the cause. The chronic form is eminently curable if the cause be removed and the kidneys be not affected. Even if the cause still remain, unless it produce ulceration of the mucous membrane (such as a malignant growth), the affection may be palliated sufficiently to prevent suffering and the shortening of life. The less acute form, if speedily relieved, is also in most cases curable. Severe injury to the bladder usually excites inflammatory processes which extend beyond the organ itself, and the patient dies rather from the effects of the disease on other organs than from cystitis itself.

Treatment.—In all cases of cystitis the first step is to ensure that the bladder shall be completely emptied as often as is needful to restrain the frequent call to void urine. A good measure of the proper length of the intervals between the passings of the catheter is the number of hours of ease which the patient enjoys after the bladder has been cleared. As the irritation subsides, the catheter may be used only once or twice in twenty-four hours; but until the patient can completely empty his bladder naturally, the residual urine should be regularly removed for him. When required only once or twice a day, the patient will easily learn to perform this little operation for himself. If the cystitis be due to stricture of the urethra, widening of the contraction alone often suffices to cure the affection. Where the cause is enlarged prostate, regular evacuation of the bladder by instrument must be maintained for the remainder of the patient's life. In manipulating on such patients, the utmost gentleness must be observed, and small, pliant catheters employed that will slip past the obstruction readily. *See* CATHETERS.

If the call to micturate be very frequent, the effect of tying in a soft catheter should be tried—one of soft rubber if it can be passed—in order to drain the bladder continuously. Unfortunately this plan, though usually soothing, cannot always be carried out if the patient has not been previously accustomed to the passage of instruments; because in many persons the constant presence of a catheter soon excites pain at the neck of the bladder, with febrile disturbance and increase of the local inflammation. If this condition arise, the catheter must be removed, and be passed every three or four hours until the urethra has grown tolerant of the instrument. This usually happens in a few days, when the instrument may be tied in again. In certain cases also, though the constant presence of the catheter is borne, the viscid mucus chokes it, and the catheter must be removed for cleaning. Hence, in the majority of cases, the catheter should be passed when needed and not be tied in.

Injections, when the acuteness of the inflammation is past, are useful; but while that is at all acute, the mechanical distension of the bladder, however gently it is done, commonly gives pain. In the very severe traumatic form of acute cystitis, all that can be attempted is the injection of an ounce or two of tepid water to clear away or to dilute the thick mucus, when it clogs the eyes of the catheter.

In chronic cystitis, when the bladder is not tender on pressure, injections are a valuable resource. In the first place, the interior of a bladder is often so altered by imperfect contraction of the muscular coat, by sacculation, or by obstruction at the neck, that it is impossible to completely empty it. The warm water dilutes the residuum, washes out the remainder of the muco-pus, and thus replaces with simple water the small quantity of decomposing urine that irritates the mucous membrane. So, also, when the amount of mucus is small, and the catarrh due mainly to imperfect evacuation from atony of the bladder, a cold injection will stimulate muscular contraction. It must be moderately cool at first by using water of the temperature of the room; and, when the patient is habituated to that, by chilling the water artificially to 45° or 40° F. Certain astringent drugs dissolved in the water also appear to be beneficial. A valuable one is the sulphate of quinine, in the proportion of two grains and two minims of diluted sulphuric acid to the ounce of water.

If the urine be fœtid, or contain much pus, injection of this solution twice daily will clear away in three or four days all fœtor, and greatly check the secretion of pus. Quinine is especially serviceable when the urine contains free ammonia. When the deposit is mainly flocculent mucus, the nitrate of silver, one-fourth or one-half of a grain to the ounce, is sometimes beneficial, but it should always be discontinued if it cause pain. Sulphate of zinc or sulphate of copper may be employed in similar cases at the same strength. But all astringent salts are very uncertain remedies. Boracic acid and borax are soothing, perhaps more so than plain water; and they appear to check the formation of the tough mucus which clogs the catheter. The cold saturated solution of boracic acid must be warmed by immersing the bottle containing it in hot water before using it. A solution of borax, eight or ten grains to the ounce, with as much glycerine, appears to have the same effect in arresting the secretion of muco-pus. Carbolic acid, in the proportion of one part in sixty of water, is also employed to check inflammation and as a disinfectant, but the writer has not seen any other good result from the use of this agent. On the contrary, it is apt to cause pain and irritation, and hence should be used only in cases of chronic catarrh. As a purifier of the instruments used, carbolic acid may be added to the lubricating oil, in the proportion of 1 to 16, with advantage.

The mode of injecting is the same whatever solution is employed. An indiarubber bottle, holding four or six ounces, is fitted with a tap and nozzle which will enter the catheter. This is carefully filled to drive all the air from it, and when the urine has been drawn from the bladder, one or two ounces, according to the irritability of the viscus, are thrown in. The fluid must never be forcibly driven in, nor in quantity sufficient to cause pain. The injection is at once allowed to escape by removing the nozzle from the catheter. A fresh portion is then thrown in and run off until the fluid returns from the bladder clear of mucus.

The patient should always lie down when this operation is first practised; but when he has become used to it, especially if the bladder does not empty itself readily, he may stand up and lean against a wall during the washing. He can thus learn to wash the bladder himself, either with an elastic bottle, or with a glass funnel and a short length of indiarubber tubing, down which he can pour and extract successive portions of lotion until the bladder is clear.

In chronic cases, when the mucus is copious and tenacious, it is well to use a No. 20 or No. 22 (French scale) flexible catheter of single web and large eyes, to which a four-ounce bottle, with Weiss's wide tap, is fitted. This apparatus, being of great interior calibre, allows larger clots of mucus to escape from the bladder than will come through an instrument of fine bore. The bottle may be used also as an exhaust by allowing it to expand after compression, while still attached to the catheter. In this way, fœtid urine and tenacious clots can be sucked away from the bladder. The bottle must, of course, be refilled with clean solution two or three times during the operation.

Calculi and phosphatic concretions must be crushed and cleared away at one sitting: the sooner the better, unless the cystitis be very acute, when it is better to reduce the intensity of the inflammation by rest and drainage before submitting the patient to so severe an operation as lithotrity. The thorough removal of all foreign collections from the bladder usually cures the cystitis when it is due to this cause. This fact should be never forgotten when chronic cystitis follows lithotrity. In most cases it is due to a fragment of stone having been left in the bladder. The writer has seen thorough cleaning of the bladder cure cystitis for a time, even when a malignant growth in the wall of the bladder was the cause of the cystitis. Though the arrest of the cystitis was only temporary, the fortnight or three weeks passed without pain was very important to the patient.

There are certain cases of cystitis which do not yield to the methods described; for example, cases of large and very irritable prostate in old men, or of tubercular disease of the neck of the bladder in young men. Here, relief from the agony of constant, painful micturition can always be given by incision into the membranous urethra in the perineum between the bulb and the prostate, through which the bladder may be continuously drained. In tubercular ulceration the benefit is sometimes marvellous. In huge prostatic deformity the mere incision into the membranous portion is not always enough, and a tunnel through the substance of the prostate has been successfully made to give ease to the patient's suffering.

The general regimen of a patient with cystitis is important. Locomotion and exposure to cold must be scrupulously avoided. During the acute stages the patient must keep his bed absolutely. When the affection is subacute, he should stay in one room and be chiefly in the horizontal position. If sufficiently recovered to bear exercise, walking is better than driving in a chair or in a carriage. Long journeys should not be undertaken while any cystitis remains. A long railway journey has often excited a violently acute cystitis when the patient has been suffering from the chronic form or from urethritis. The body should be very warmly clad, especially the abdomen and the lower extremities, to produce free action of the skin. The diet should be light; all stimulants containing alcohol prohibited; also effervescent drinks, coffee, tea, and cocoa should be avoided, coffee and tea altogether, and cocoa taken only in small quantities and weak. Milk should be largely given, and if the kidneys are gravely affected, it may be, with or without ice, the only article swallowed. Where solid food is given, no more liquid should be drunk than is needed to quench thirst, that the secretion of urine may not be stimulated beyond what is unavoidable. Icing the barley-water, toast-and-water, or other drink, also renders it a better quencher of thirst, and therefore less will suffice. Of medicines which are reputed to affect cystitis, acute or chronic, directly, decoctions of triticum repens, or of alchimella arvensis, are perhaps the most likely to be effective; but their influence is very uncertain. To allay spasm and pain, opium and extract of belladonna are useful in suppositories. Belladonna must be cautiously employed, especially in elderly men, lest it increase the loss of tone of the muscular coat, and it should be given only when the pain is acute. In chronic catarrh, decoction of pareira brava with four or five minims of copaiba, or oil of sandal-wood in small doses, is useful. Benzoic acid in four-grain pills, at the rate of six or eight pills daily, is sometimes beneficial as a balsamic in chronic catarrh. More trustworthy in cases of subacute cystitis is buchu tea. Unfortunately, both pareira and buchu are apt to produce indigestion, and thus cause more discomfort than they allay. When given at all, they should be given in large quantities; in every twenty-four hours, 1 or 1½ pint of the decoction to be drunk, in three or four portions. Acids, except the mineral acids, in small tonic doses, are of no avail. Alkalinity of the urine in cystitis is due to the conversion of urea into carbonate of ammonia, and its production will be prevented by clearing the bladder of decomposing urine and pus. In cases of chronic cystitis due to atony, alkalies are chiefly beneficial when the patient is gouty and the urine highly acid.

For the acute cystitis which is a complication of gonorrhœal urethritis, the catheter is seldom needed, and injections would be mischievous. The *treatment* consists in the frequent use of sedatives in the form of very hot hip baths (104°–110° F.) for ten minutes, hot poultices, belladonna suppositories, eight to ten leeches to the perineum, subcutaneous injections of morphia, or of morphia and atropine, saline aperients, and low diet. Liquor potassæ, with tincture of henbane or of belladonna in camphor water, is also a very useful sedative in these cases. They may be given alone, or decoction of triticum repens may be given as well.

For old chronic cases, the winter should be passed in a warm climate; and a course of the sulphur waters at Bath, Strathpeffer, Harrogate, or Schlangenbad will greatly increase the tone of the bladder, and notably diminish, when it does not wholly remove, the muco-pus from the urine.

NEURALGIA OF THE BLADDER.—Pain, referred to the bladder, almost always to its neck, without actual disease of that part, is caused by a great variety of local affections and also by certain conditions of general disturbance. Nearly always the cause can be traced, and its removal cures the pain. Nevertheless, in a very few cases, the cause cannot be discovered: such, for want of a better knowledge of their origin, are termed *simple neuralgiæ*. In health the neck of the bladder is at all times highly sensitive, and often suffers from increased sensibility when other viscera are affected; while the remainder of the bladder, unless diseased (by inflammation or ulceration, for example), is probably quite insensible to the touch of foreign bodies.

The causes of painful conditions of the bladder, it has been already said, are most numerous. In respect of age, the middle age mainly suffers from this affection, though neither old age nor childhood is exempt. Of specific local causes, all which interfere with the evacuation of the bladder are sources of pain to this viscus—viz., stricture, enlargement of the prostate, calculi, gravel, atony of the bladder, tumours or indurations of its walls. The passage of sounds, falls on the perineum, pressure by the gravid or displaced uterus, constipation and loaded rectum, even excessive purging, may excite this form of pain. So, also, disease of the kidney, womb, or rectum; especially fissure of the anus, piles, or ascarides may set up nervous pain in the bladder. More distinct causes are disorders of the digestion, imperfect function of the liver or stomach, indulgence in certain alcoholic drinks such as punch, imperfect assimilation of food, or changes of tissue which produce highly acid urine or excess of uric acid, or the reverse—neutral urine with excess of phosphates. Exposure of the surface of the body to cold or a sedentary life are also causes of pain commencing in the neck of the bladder, but radiating widely elsewhere. Persons of rheumatic, gouty, or nervous constitution are prone to suffer from these pains. Excessive coitus and masturbation frequently set up pain at the neck of the bladder, principally through provoking long continued congestion of the erectile tissue and vascular structures placed there; probably also in part through the nervous prostration which follows these excesses. The debility resulting from long residence in hot moist climates, especially when the patient has suffered from malarial fever, both favours the production of the pain and increases its severity. Some of the most severe cases which the writer has seen have been in anæmic patients from India, the Straits' Settlements, or the Philippines.

The *symptoms* vary in different persons. Frequent calls to void urine are generally present, though not always so. Pain, usually intermittent—almost constant in severe cases—is felt in the perineum. It is variously described as an aching, as a sense of weight or of tightness, increased by sitting on a cushioned seat or when the sensitive neck of the bladder is pressed by the weight of the body. In some persons the pain is referred to the suprapubic region, in others to the symphysis. This form is more common in persons who indulge too much in stimulating food and drink. The pain is rarely confined to the localities just mentioned, but radiates to the groins, insides of the thighs, loins, sacrum, and lower part of the belly. It is often accompanied by depression of spirits and anxiety, or by irritable temper. The pain is usually worse by night than by day; that is, when the body is warm in bed and the genital organs congested by sleep. It is also very severe in persons of whose families some members suffer from ordinary gout, and who, though no local affection connected with the pudenda be detected in themselves, have eczema elsewhere more or less severely. In certain patients—usually those afflicted with dyspepsia—there is a tendency to spasm, and the patients are much alarmed by a liability to difficulty in micturition, which their fright may exaggerate to almost complete retention. Such spasm is, of course, quickly allayed by a hot hip-bath, a saline purge, or other simple remedy. In all cases the affection is very apt to return if the original cause be permitted to regain activity.

The *treatment* is general and local. The general treatment consists in removing the functional disturbance, if any exist; in ensuring the proper action of the digestive organs; in curing or alleviating any local ailment; in restoring the patient's strength; and, if there be any history of previous malarial attack, in using arsenic, bark, or quinine in full doses. A diet and regimen must be observed which will prevent the reproduction of the condition which favoured the excitation of the neuralgia. Thus the diet must be light but nutritious; alcohol must be most sparingly taken—to be wholly avoided in nearly all cases. Laxatives and diluent drinks, to render the urine of low specific gravity and of weak acidity, are needed. Long journeys are hurtful, particularly railway journeys, which in many persons excite prostatic congestion; and sexual commerce must be kept at a minimum.

The local treatment consists in the cure of any ailment discovered on careful examination of the urinary organs with the sound and finger in the rectum. When signs of disease are absent, the cautious passage of full-sized sounds at intervals of two or three days is often very effective. They may be followed by tepid injections into the bladder, slowly given, and at first not more than two or three ounces at a time; then increasing to six or eight ounces as the bladder becomes habituated to the distension. The injections may be cooled to 50° or 40° if the tepid ones fail to relieve pain. Tepid douches to the hypogastrium, perineum, or the sacro-lumbar regions, are sometimes beneficial. They should be applied for ten or twenty minutes if they cause no pain. Counter-irritation also, in the form of blisters to the perineum—small, and frequently repeated, are occasionally serviceable; but the writer has seen this remedy more often increase than allay vesical neuralgia. In some cases of general debility, without any marked functional derangement, local treatment has effected a complete cure in less than a month, but such success is not to be counted on. The most trustworthy treatment is a careful attention to diet and regimen, and to restoring the general health of the patient.

Berkeley Hill.

BLADDER, Extroversion of the. *See* Ectopia Vesicæ.

BLADDER, Puncture of the.—When a patient is suffering from retention of urine, from whatever cause, and the surgeon is unable to introduce a catheter, the bladder is punctured by trocar and canula, and the urine evacuated. The operation is occasionally employed in enlarged prostate, and tumours of the bladder and prostate, when acute retention of urine is not present. It is also practised by some surgeons in the treatment of certain forms of urethral stricture.

Before puncturing the bladder for retention of urine, the surgeon must satisfy himself that retention is really present, and must have made every effort to pass a catheter (*see* Retention of Urine).

The bladder may be aspirated above the pubes, or it may be tapped (1) above the pubes; (2) by the rectum; (3) from the perineum: (4) through the symphysis pubis; (5) under the symphysis pubis.

When there is hope that the relief from retention will only be required temporarily, *supra-pubic aspiration* of the bladder is the safest operation. Should retention recur, aspiration may be repeated two or three times with safety, and it has been performed ten or twelve times in immediate succession without bad result; at the same time it should be remembered that fatal extravasation and abscess have followed a second introduction of the needle. It will therefore be wise, if aspiration has to be several times repeated, to tap at once above the pubes with trocar and canula, leaving the canula or a catheter in the wound. Supra-pubic tapping ranks next to aspiration in safety and convenience. Rectal tapping is falling into disuse, owing to the obvious inconvenience it causes the patient. The other methods are surgical curiosities.

1. (*a*) Supra-pubic Aspiration of the Bladder consists in the introduction of a fine trocar into the bladder above the pubes, and in the withdrawal of the urine through the trocar by pneumatic aspiration. No anæsthetic is necessary. There are many aspirators sold, the best perhaps is usually called Potain's; it consists of an exhausting syringe attached to a cork, which can be fitted into a wine decanter or any other bottle sufficiently large, and through the cork also passes another tube connected with the trocar. The receiving bottle is exhausted. The patient lies upon his back with the knees slightly raised; an assistant steadies the distended bladder by pressing with his hands in each iliac region, and the trocar, having been carefully carbolised, is thrust through the skin about half an inch above the pubes downwards and backwards into the bladder; then a tap is turned and the urine flows into the receiver. Aspiration should be kept up during the removal of the canula, to prevent the escape of any urine into the tissues. This operation may be repeated perhaps twice or thrice, when, if no instrument can be passed by the natural passages, the surgeon is recommended to perform—(*b*) *Supra-pubic tapping*. It is desirable, but not absolutely necessary, to administer an anæsthetic. The pubes should be shaved, and a small incision made, about an inch long and ending half an inch above the pubes, through the skin and fat down to the linea alba. An assistant steadies the bladder, and a curved trocar (the ordinary rec-

tal trocar is very suitable) is then pushed through the linea alba downwards and backwards into the bladder. The urine is allowed to escape, and if the canula is a small one it can be tied in by tapes attached to a T-bandage and plaster. Or, better still, a soft catheter can be introduced through the canula and be tied in. After the canula is removed, a piece of tubing can be attached to the catheter, and the urine can thus be led into a receptacle by the side of the bed. The operation is simple and safe, and the bladder is easily drained until an instrument can be introduced through the urethra.

If for any reason the surgeon prefers to tap the bladder by the rectum it is done as follows:—

2. Rectal Puncture of the Bladder. The bowel is cleared by an enema, an anæsthetic administered, and the patient is held in the lithotomy position. While an assistant presses the bladder downwards the operator introduces the first and second fingers of his left hand into the bowel and defines the prostate, especially its upper border. He then takes the rectal trocar in his right hand, *with the point drawn just inside the canula*, and introduces the instrument along the groove between his two fingers which are lying in the rectum, until it has fully passed the posterior margin of the prostate. The handle is then firmly depressed, and the trocar and canula are thus pushed into the bladder. After the urine is drawn off the canula can be removed or retained as the surgeon deems best. This operation has many disadvantages. It is somewhat dangerous and may lead to troublesome fistula. It can rarely be required now.

3. Puncture through the Perineum. A large, straight trocar and canula are used. The patient is held in the lithotomy position. The surgeon's left forefinger is passed into the rectum, and the trocar is thrust into the perineum about an inch above the anus and pushed, upwards and backwards, into the bladder. The canula can be retained.

4. Puncture through the Symphysis Pubis.—A medium-sized hydrocele trocar is used. It is introduced, without preliminary incision, through the centre of the symphysis, and pushed downwards and backwards into the bladder.

5. Puncture under the Symphysis Pubis.—The penis is forcibly pulled downwards and backwards and the trocar thrust under the pubes into the bladder.

G. Buckston Browne.

BLADDER, Rupture of the, is a breach in the vesical wall, caused either by external violence, or by forces acting within the body itself. In the former case the rupture is *traumatic*: in the latter *idiopathic*. In either form ruptures fall naturally under two heads: *extraperitoneal* and *intraperitoneal*; the former including (*a*) *partial* ruptures, or rents in the mucous coat only, or in the mucous with part of the muscular; and (*b*) the important group of *subperitoneal* ruptures. Occasionally multiple rents are found in an injured bladder.

1. The *causes* of ruptures are divisible into *predisposing* and *determining*. Distension of the bladder is the main predisposing condition of an uncomplicated traumatic intraperitoneal rupture, and is present in the great majority of instances of ruptures of all kinds. When the viscus is empty, or contains but a small quantity of urine, a rent in the bladder anteriorly may be occasioned: (*a*) by a fractured pubic ramus; (*b*) by great violence applied to the hypogastric region, as when the wheel of a heavily laden waggon passes over the abdomen, or a mass of earth falls on the part; and (*c*) by the same force by which the innominate bones are violently separated at the symphysis pubis. The base of the bladder may also be split by disruptive force, which tears open the perineum and lacerates the rectum. Other predisposing causes are intoxication, and some obstacle to the passage of urine from the bladder. Differences of habit and occupation render males far more liable than females to rupture of the bladder. In the *traumatic* cases the determining cause is usually some force applied to the hypogastric region. Even the strain of the abdominal muscles against the distended bladder in falls backwards, and lifting heavy weights, may suffice to occasion the lesion. Violence applied to the back has also been noted as a cause of rupture in several cases. The site of the rent will depend upon the degree of distension, the nature and mode of application of the violence, and the position of weak spots in the bladder-wall.

Idiopathic ruptures include all cases in which no external violence has been applied to the abdomen; ruptures from over-distension due to various causes, as, e.g., stricture, enlargement of the prostate, hysteria, retroversion of the gravid uterus, extra-uterine fœtation, labour, and alcoholism; ruptures in the fœtus, and ruptures due to ulceration, the result of certain diseases, viz. fever, erysipelas, syphilis, tubercle, cancer, and calculus.

2. *Pathology.*—In the *idiopathic* cases rupture is often preceded by some change in the organ itself. Thus long-continued obstruction to the passage of urine, whether from stricture or enlargement of the prostate gland, occasions hypertrophy of the muscular fibres of the bladder, and the formation of 'tunicary herniæ,' or diverticula of the mucous membrane, which protrude through the muscular fibres, commonly either at or near the summit of the bladder, or posteriorly at the level of the insertion of the ureters. As these pouches are sometimes immediately under the peritoneal tunic, and sometimes unconnected with the serous coverings, ruptures due to stricture or hypertrophy of the prostate may be either intraperitoneal or extraperitoneal. A second condition, occasioned by obstruction of the urethra, especially when instruments have been passed, is inflammation of the mucous membrane of the bladder, determined, perhaps, by decomposition of retained urine. The inflammation may end in ulceration, softening, sloughing, or gangrene of some spot in the bladder-wall, a termination exemplified in cases of rupture from retroversion of the gravid uterus, and some prostatic cases. A third effect of obstruction is thinning and weakening of the vesical tunics. The final cause of rupture may be muscular action in efforts to pass water, and straining at stool. In rupture during labour the neglected and distended bladder is placed between two forces, the contraction of the abdominal muscles and some part of the child's body, or the forceps of the medical practitioner. The rent may either be into the peritoneal cavity or into the vagina. After the completion of labour rupture may occur sooner or later in consequence of the injury sustained by the bladder during the process, and from subsequent neglect.

Each kind of rupture has its own form of breach in the bladder-wall. The ordinary form of uncomplicated rupture from blows, kicks, and falls, is a lacerated rent, one inch to three inches in length, vertical, oblique, or transverse. The more or less vertical rent at the upper part of the posterior wall of the bladder, commencing near the urachus, is the most typical, and results from the sudden application of equable violence to the hypogastric region, driving the fluid against the posterior wall, which is burst open by the expanding force. In retroversion of the gravid uterus, the opening is either a rent with gangrenous edges, or a sloughy hole or gangrenous perforation. In cases of stricture and retention, where the rupture follows over-distension and straining, the aperture is usually a small perforation, or a short rent of about half an inch, or a triquetrous opening, or a round hole lined by mucous membrane. In cases of hypertrophy of the prostate, the opening may be smooth and rounded, or a narrow rupture with thinned or sloughy edges.

In *traumatic* cases blood is often poured out freely. Submucous extravasation will be found, either confined to the neighbourhood of the rent, or spread over a wider area. A considerable amount of blood has been found in some intraperitoneal ruptures in the cavity of the abdomen, whilst in some of the extraperitoneal cases blood may collect and form a swelling in the hypogastric region. After rupture the bladder either collapses or contracts, and is usually incapable of holding more than a few ounces of urine.

3. *Symptoms.* — The typical primary symptoms of rupture are a feeling of something giving way, excruciating pain, shock, inability to stand or walk, desire, but want of power, to micturate, and removal from the bladder with the catheter of blood only, or a small quantity of bloody urine. When the point of the catheter impinges against a sound portion of the viscus, it will be found difficult to rotate the instrument and to depress it between the patient's thighs, but if there is an intraperitoneal rent on the posterior wall, the catheter may suddenly slip through the opening into the peritoneal cavity, become freely movable, and withdraw a large quantity of fluid in place of the small quantity of blood, or the few ounces of blood and urine, previously removed. As the contraction of the muscular fibres of the bladder cannot assist the flow, and as the abdominal muscles are exerted only for the business of respiration, the urine will either well out gradually and run down by the side of the catheter, come out almost *guttatim*, or pass from the instrument in an intermittent stream during the periods either of inspiration or expiration. As a general rule the patient from the first is unable to make water, and may continue to exhibit this inability to the end. Ability to micturate, however, has been observed both in intraperitoneal and extraperitoneal cases, and in both sexes. It is relatively more frequent and in greater perfection in the extraperitoneal cases. Sometimes the patient passes water, with or without difficulty, immediately after the accident, and not subsequently, sometimes in small quantities throughout the illness, sometimes on the second or third day, and

sometimes at a later period. When passed it is generally with difficulty, and the amount will be less than it ought to be. Occasionally there will be incontinence of urine. Very rarely indeed the patient may pass water naturally every day and be independent of the catheter.

In the *intraperitoneal* ruptures the symptoms are decidedly more severe than in the extraperitoneal cases. The shock at first is greater and the well-known symptoms of peritonitis speedily supervene. The patient will lie in bed with his knees drawn up, or be propped up with pillows, to relax the abdominal muscles. He will have a pinched, anxious, haggard, and even ghastly expression of countenance, look pale and anæmic, and be tormented with a frequent or constant desire to pass water, leading him to make many ineffectual efforts to empty his bladder. He will suffer from thirst, and sooner or later be troubled with vomiting, bringing up a greenish-yellow liquid, and even the water which he has drunk copiously to quench his thirst. The pulse will be small, feeble, irregular, and rapid, varying between 90 and 130, and the respirations hurried. The abdomen will be tense and tender, tympanitic above, dull and fluctuating below. There may even be a more or less defined and fluctuating swelling, resembling the bladder, between the umbilicus and the pubes, due to urine temporarily confined by the disposition of the coils of intestine. Throughout the illness there will be marked restlessness and insomnia. As the case proceeds, the symptoms become aggravated, the swelling and tension of the abdomen increase, clammy sweats appear on the skin, the hiccough and vomiting become more urgent and distressing, the pain is intolerable, the countenance sunken and ghastly, the voice low and feeble, and the patient may sink into a state of collapse, or into a typhoid condition attended with delirium and coma. If the patient survive so long, there may be marked signs of amendment about the fifth or sixth day. The rent in the bladder is under repair, or gets blocked up by intestine or omentum, and the patient may sit up in bed, pass water voluntarily, take food without rejecting it, be freer from pain and comparatively cheerful. Relapse speedily occurs, and the patient sinks.

In *extraperitoneal* cases, the general and local symptoms will be those usually attending extravasation of urine. When the rent is in front, the urine either forms a circumscribed collection outside and anteriorly to the bladder, occasioning marked dulness on percussion; or it becomes widely diffused, mounting up towards the umbilicus between the peritoneum and abdominal muscles, and then finding its way to the subcutaneous fascia or into the peritoneum, or passing into the iliac fossæ, or through the obturator foramina and the inguinal and femoral canals into the scrotum and thigh. When the rent is behind the prostate, the fluid will ascend into one or other of the iliac fossæ. Wherever extravasation occurs it sets up inflammation of the connective tissue and fasciæ, followed in due time by suppuration and sloughing. Occasionally the urine is collected in a kind of sacculus, the walls of which are composed of connective tissue thickened by lymph, simulating the appearance of a lining membrane to the adventitious cavity.

Diagnosis.—The chief mistakes which occur in practice are: 1. Overlooking the lesion altogether, or mistaking it for some other affection, such as peritonitis. 2. Mistaking an extra-peritoneal for an intraperitoneal rupture. 3. Mistaking a contusion of the bladder or of the abdomen for a rupture of the bladder.

The first mistake is not likely to occur to a well-informed and sagacious practitioner, if the case is typical. Clear evidence of fulness of the bladder at the time of the accident, of violence applied to the hypogastric region, of the occurrence of the typical primary symptoms, and the results of examination of the bladder and abdomen, will establish the diagnosis beyond a doubt. But the surgeon may have to do with a patient under the influence of alcohol, who recollects nothing, and felt nothing of the accident, and he may have to trust mainly to his own skill in interpreting symptoms and in manual and instrumental examination. The behaviour of the catheter, the nature and quantity of the fluid withdrawn by it, and the total or restricted ability of the patient to micturate, will be the most reliable guides. If these are insufficient, the bladder can be injected with a warm solution of thymol. If the bladder be sound, it will form a circumscribed tumour in the hypogastric region, and the fluid will be recoverable; if ruptured, the fluid will become diffused among the intestinal coils, be felt by the patient in the flanks, and will not return readily or completely through the catheter.

The second mistake will be less likely to occur if the surgeon carefully considers the mode of occurrence of the injury, whether it is complicated by fracture or not, and the effects of catheterism. In extraperitoneal ruptures, fracture of the pelvis is a frequent cause or accompaniment of the bladder-lesion; the primary symptoms are less marked, the constitutional condition less serious, the catheter rarely leaves the bladder, and evidence of extravasation in the hypogastric region, flanks, scrotum, or thighs, will soon be forthcoming. If the surgeon is satisfied that the bladder is ruptured, but cannot arrive at a certain conclusion as to the kind of rupture present, he can either explore the bladder from the perineum, or make an incision immediately above the pubes, and examine the anterior aspect of the organ, before proceeding to open the peritoneum.

The third mistake arises chiefly from over-estimating the amount of urine in the bladder at the time of the accident; through attending to the time which has elapsed since micturition without regard to the quantity of liquid ingested; from forgetting that the secretion of urine is often either suppressed or greatly diminished for some hours after severe abdominal contusion; and from regarding the passage of a catheter by a medical practitioner, and failure to draw off urine, as necessarily indicating an empty bladder.

Treatment.—As there is no indubitable case of spontaneous recovery on record after intraperitoneal rupture of the bladder, it is essential that the surgeon should form his diagnosis immediately, and act without delay. The indications are mainly two: first, the removal of the effused urine, and secondly, the prevention of the further escape of urine through the rent in the bladder into the perivesical connective tissue or the peritoneal cavity. For these purposes the intermittent use or constant retention of a *catheter* in the bladder, attempted *washing out* of the peritoneal cavity or adventitious pouch in the perivesical fascia through the rent in the bladder, *tapping* the recto-vesical cul-de-sac, and *paracentesis abdominis*, either with an ordinary trocar or the aspirator, are not trustworthy.

The peritoneal cavity can only be efficiently cleared of urine and blood by *abdominal section* and careful and thorough sponging. Prevention of further accumulation and transmission of urine into the peritoneal sac in the male may be secured by sewing up the rent in the bladder with carbolised silk sutures, with or without paring the edges of the ragged rent. If this procedure be adopted, the bladder should be injected with water before the abdominal wound is closed, to make sure that leakage is not possible. Perineal urethrotomy, either median or lateral, should then be performed, the lateral operation being preferable. A tube can be retained in the bladder. Some surgeons prefer the performance of perineal urethrotomy or cystotomy in the first instance, and abdominal section afterwards, and if there is any doubt as to the diagnosis, a preliminary exploration of the bladder would remove it; otherwise the sequence of procedures cannot make any difference. After the operation, hypodermic injections of morphia will be of service. Abdominal section ought to be performed within the first twenty-four hours to have a good prospect of success, and further experience is required to test the value of all operative measures.

In the female, intraperitoneal rupture of the bladder should be treated by vaginal cystotomy and abdominal section, with careful cleansing of the peritoneal cavity.

In extraperitoneal ruptures, cystotomy, combined with incisions above the pubes and into any parts where extravasated urine finds its way, will offer the best prospect for the patient. WALTER RIVINGTON.

BLADDER, Tumours of the.—Tumours of various kinds have long been recognised as affecting equally the male and female bladder. Those of a cancerous nature have been more familiar to surgeons than other forms of less malignant tendency, and hitherto accounted rare. During the last ten years the latter have been studied, and also found removable by operation in some instances, a condition which does not characterise cancerous growths.

The greater number of these, namely, twenty-three cases, have occurred in the experience of the writer; hence the result of his researches will form the chief basis of the present article.

Tumours of the bladder may be classified as follows:—I. Tumours composed of homœoplastic elements.

1. The *simple mucous polypus* at present met with only in the bladders of children, and mostly appearing to be analogous in structure to the soft nasal polypus, a form of myxoma; while occasional specimens contain, in addition, more of the deeper normal fibres of the structures from which the growth arises. The growths are numerous, evidently rapidly formed, soon fill the bladder, and in the case of female children sometimes issue by the external meatus, and present in the vagina.

2. *Papillomatous Tumours.*

a. Fimbriated Papilloma is now held to designate that product which has been familiarly known as the 'villous' growth, a term which is objectionable on several grounds. The most obvious character of the growth is a structure in which the vesical mucous membrane is developed into fine papillæ, which consist of long fimbriated processes of extreme tenuity, and usually form a group arising from a small circumscribed base.

b. Fibro-Papilloma. Here the papillary processes, although present in more or less abundance, do not constitute the chief part of the structure, which is more solid than the preceding, and consists of the constituents—unstriped muscle and connective-tissue fibres—of the submucous tissues of the vesical coats. The papillæ are sometimes shorter, less developed than, the 'fimbriated' processes of the previous division.

3. *Transitional Tumours.*—This term is for the present used to designate certain examples of tumour, the chief structure of which is that of 'fibro-papilloma' just described; but presenting also, intermixed, some suspicious-looking cells, which may be merely leucocytes, but which may sometimes suggest to the observer that the growth is intermediate in structure between the foregoing and a formation of a malignant type, 'sarcoma.'

The three foregoing varieties are, comparatively speaking, by no means uncommon.

II. Tumours composed of heteroplastic elements:—

a. Epithelioma.

b. Sarcomata, round and spindle celled; rare.

c. Scirrhous, encephaloid, and melanoid cancers.

d. Dermoid tumour; rare.

Symptoms.—Regarding the forms most commonly met with, or those of the first group, the earliest symptom is mostly hæmorrhage; and it occurs before unduly frequent micturition is complained of, and before it is painful. On the other hand, when the tumour is of the malignant type or approaches thereto, pain and frequency of passing water generally precede the appearance of blood, sometimes for a considerable time. There is nothing very characteristic in the hæmorrhage, excepting the one important circumstance always to be inquired for, and, if possible, to be observed by the surgeon himself; namely, that in the act of micturition the stream may sometimes commence without any blood-stain, or with only a slight admixture, and end of a bright red colour from the presence of much fresh blood. With such an occurrence, and no recent urethral lesion having been made, the source of hæmorrhage must almost always be vesical. Supposing in such circumstances that the absence of stricture, ordinary diseases of the prostate, calculus of the bladder, and cancer have been ascertained by sounding and by rectal examination, it remains only to observe certain products which the urine itself may contain.

Very little positive evidence is obtained by rectal and vesical examination except in hard, cancerous deposits, which are thus easy to identify. The result is generally negative, or nearly so, when a growth of the papillomatous or of the allied variety is present.

The examination of the urine, however, is highly important. Its object is to obtain disintegrated portions of the tumour if present, and to identify their structure under the microscope. An excellent way of obtaining such specimens is to wash out the bladder freely with warm water. It rarely happens that this process fails to detach fragments sufficient for our purpose if there is a growth in the interior.

The presence of a non-cancerous tumour being verified or strongly suspected, the bladder should be explored, and the tumour removed if practicable; no other treatment is of any service. The best mode of accomplishing this is by external urethrotomy, a simple procedure involving little or no risk, and not by cystotomy—some rare cases excepted—since it is always more or less dangerous.

Operation.—The steps of the operation which the writer adopts are as follows:—The position of the patient and the accessories are the same as for lithotomy. A median staff with a short curve, deeply grooved, is passed into the bladder, and the patient is held by two assistants in the usual manner, another holding the staff. The surgeon introduces into the rectum his left forefinger, so as to feel with its tip the position of the grooved staff, and verify the apex of the prostate, on which he places his finger as a guide. Maintaining his left index in the position described, he makes, with a long, narrow, straight-backed bistoury, a vertical incision through the skin and cellular tissue in the middle line, about an inch and a quarter long, the lower end terminating about three quarters of an inch above the anus. He next enters the bistoury, with its cutting edge upwards, in a horizontal direction, at the lower part of the incision, just above the upper border of the bowel and parallel with it, and guided partially by the left index, directs the point to the membranous urethra, which it penetrates, entering firmly the groove of the staff. He then incises the urethra on the staff for a few lines, and withdraws the bistoury, cutting slightly a little of the tissues upwards as he does so, avoiding as far as possible any section of the bulb itself, and making room enough only for the finger to enter. He now inserts in the groove of the staff a tapering director and presses it inwards along the urethra to the bladder: when arrived there the staff is withdrawn, the director remaining, and on it the left index is gently insinuated to the neck of the bladder, entering which, he at once recognises the form and position of the growth, and determines whether he can or cannot attempt to remove it.

If the surgeon finds a polypoid growth he should introduce a pair of forceps into the cavity of the bladder, and use them without aid from the finger. The forceps should have wide and serrated margins where the blades meet, so as to crush, but without power to cut, the tissues seized, and should be provided in different forms. The simplest should be like an ordinary lithotomy forceps. Others should be curved, for seizing tumours which are situated laterally and near to the neck of the bladder, in which last-named position the straight forceps is powerless to grasp the tumour. When the blades are free, if they are opened easily and widely, the polypus is almost sure to be within their grasp. No suprapubic pressure, as a rule, should be made during this act, so as to disturb the contour of the bladder. He should never drag or pull forcibly, but rather 'bite' off the growth with the blades, twisting it somewhat perhaps. After this the finger alone may often remove it safely. Every time the forceps has removed a portion, the finger should examine the interior, before the forceps is introduced again. And in no case where the tumour is a flattened growth with broad base, should an attempt be made to separate it very near to the walls of the bladder, which might thus be fatally injured.

There is one circumstance important to be noted, especially in dealing with the less prominent growths, viz., the effect of strong supra-pubic pressure made by an assistant in relation to their mode of presentation to the finger of the operator engaged in exploring the bladder, and in estimating their size and form. If that pressure is considerable, it forces the upper wall of the bladder into its own cavity, and thus gives to the growths a larger contour than they possess, and makes them apparently salient to a much greater extent than they really are. Thus an eager or inexperienced operator, unaware of the effect of supra-pubic pressure, might be led to seize the mass presented to the forceps by the influence of this pressure, and, under the belief that it was a large growth, he might inflict a fatal wound by crushing a double fold of the coats of the bladder, and so making an opening in the peritoneum. To avoid such a catastrophe it is only necessary, first, to decline the attempt to destroy any growth which is clearly not sufficiently salient to admit of complete or nearly complete removal; and, secondly, never to employ the forceps while forcible supra-pubic pressure is made—at least, no more pressure than is desirable just to steady and support the bladder and the parts adjacent.

But other means may be used according to the judgment of the surgeon. A very small écraseur, with violin-string ligature, may be manipulated by the side of the index finger, and used in polypoid forms of tumour. In the cases of women such a tumour may sometimes be slowly and carefully brought into view by traction on the forceps, and then the pedicle may be ligatured, as the writer has done in two instances.

After the operation a tube has usually been introduced and left for two or three days. As a rule, however, it appears advisable not to employ one.

It may be remarked, as before observed, that the incisions necessary for the proceeding are simple and harmless to the last degree. The writer has never met with any untoward result from them. The risk of removing the tumour is, however, sometimes considerable, but even this depends very much on the care, judgment, and self-command of the operator. It is not at all difficult to inflict fatal injury on the organ by an attempt to remove a growth either too completely or too vigorously.

There is good reason to believe that entire removal of the base of papillomatous formations is not absolutely necessary, and that cicatrisation prevents further development where the growth has been nearly, and not quite, removed.

The presence of cancerous disease of the bladder, and especially the scirrhous variety, may almost always be determined by rectal examination: the irregular knotty feel of the hard deposit in the situation of the prostate and beyond it are quite characteristic. Such a condition, associated with much pain, occasional bleedings, and frequent micturition, go far to establish the diagnosis. In regard to treatment, that only which renders life endurable by alleviating sufferings which inevitably become severe in the later stages of the disease, is desirable; and it consists in the administration of morphia, the subcutaneous injection being the most efficient form in these cases. It may here be emphatically stated that if the physical characters and symptoms, especially the former, indicate the presence of a growth of this nature, any operative proceedings for its removal must be not merely futile and imperfect, but extremely dangerous, and ought not to be undertaken. It does not follow, however, that in such cases the drainage of the bladder by a perineal opening may not, in certain circumstances, be a useful proceeding to relieve suffering or prolong life, &c. Henry Thompson.

BLEBS. *See* Bullæ.

BLENNORRHAGIA. *See* Gonorrhœa.

BLEPHARITIS. *See* Eyelids, Diseases of the.

BLINDNESS.—The term blindness is used in two senses—a strict or scientific sense, in which it means inability to distinguish light from darkness, and a loose or popular sense, which may mean any condition impairing vision, or, indeed, mere temporary incapacity for opening the lids, vision being otherwise perfectly preserved. In the true sense, when the patient has no longer even quantitative perception of light, blindness is always the result of some lesion of the nervous system, such disease having its seat either in the recipient apparatus or retina, in the conducting apparatus, optic nerve, chiasma, or tract, in the percipient apparatus or corpora quadrigemina and optic thalami, or, lastly, in the intellectual visual centre; situated, according to some, in the occipital lobes of the cerebrum, and, according to others, in the angular gyrus, the tract or fibres of Wernicke establishing the communication between the corpora quadrigemina and the cortex cerebri in the former case, and radiating fibres effecting the transmission of the impressions in the latter case. Congenital defects, traumatic lesions, hæmorrhage, inflammation and its consequences, syphilitic and other tumours of the brain, may attack, compress, or destroy any of these parts, and total blindness of one or both eyes may be the result.

It is impossible to determine from the censuses of this country whether those who are termed blind are only blind so far as to prevent their being educated, or obtaining their own living, or whether they are wholly incapable of perceiving light. Moreover, no clear distinction is drawn between cases of complete blindness and those in which, whilst one eye is really blind, the other still retains some perception of light.

The present article will be devoted to the consideration, not only of the completely blind, but also of those cases of great impairment of vision which, whilst varying from mere perception of light to the recognition of large objects, yet practically render the subject unable to pursue any of the ordinary vocations of life. It is, indeed, very difficult to draw any line between mere weakness of sight and blindness. There are cases, for example, of astigmatism, of cataract, and of retinal or choroidal atrophy, in which vision may be assisted, and even rendered tolerably good for a short period or for certain purposes, but, as a whole, may prove insufficient for the ordinary duties of everyday life.

It is found convenient in practice to distinguish three degrees of blindness:—(1) Complete blindness, in which there is no perception of light. Vision is then said to be abolished; $V = 0$. (2) That degree of blindness in which only the difference between light and darkness can be distinguished; $V = \frac{1}{\infty}$. The patient is then sometimes said to possess quantitative perception of light; and, thirdly, that degree in which there is qualitative perception of light, expressed by $V = \frac{1}{1000}$. In this degree the patient can distinguish large objects, masses of colour, the movement of the hand between the eye and the light, and may, perhaps, even be able to count the fingers, but is unable to do more than grope his way from place to place.

Distribution of Blind Persons.—The distribution of the blind varies considerably in different areas. Thus, in the census of France in 1861, the number of blind in the Département du Vendée was only 24 in 100,000 inhabitants, whilst in the department of Eure it was as high as 121 in the same number, a difference too striking to be attributable to defective registration.

The census returns for 1881, published in 1883, contain many interesting facts in regard to the number, distribution, and occupation of the blind in England and Wales. The total population is given at

25,974,439, and the total number of blind is returned at 22,832. Of these, 1,958 were blind from birth, a large proportion of them probably in consequence of an attack of purulent ophthalmia. Of the 22,832 blind, 12,048 are males, 10,784 are females. The distribution of the blind in England is as follows:—

Counties	Total Population	Number of Blind	Males	Females	Blind from Birth
Northern :—					
Durham	1,624,213	1,259	723	536	112
Northumberland					
Cumberland					
Westmoreland					
Yorkshire	1,420,001	2,294	1,234	1,060	223
North-Western :—					
Cheshire	4,108,184	3,004	1,628	1,376	317
Lancashire					
North-Midland :—					
Leicestershire	1,637,865	1,429	733	696	129
Rutlandshire					
Lincolnshire					
Nottinghamshire					
Derbyshire					
West-Midland :—					
Gloucestershire	3,029,504	2,914	1,606	1,308	267
Herefordshire					
Shropshire					
Staffordshire					
Worcestershire					
Warwickshire					
South-Western :—					
Wiltshire	1,859,013	2,354	1,257	1,097	174
Dorsetshire					
Devonshire					
Cornwall					
Somersetshire					
Eastern—					
Essex	1,343,524	1,308	673	635	127
Suffolk					
Norfolk					
South-Midland :—					
Middlesex, excluding London	1,596,259	1,434	694	740	119
Hertfordshire					
Bucks					
Oxfordshire					
Northamptonshire					
Huntingdonshire					
Bedfordshire					
Cambridgeshire					
South-Eastern :—					
Surrey	2,487,076	2,025	1,022	1,003	156
Kent					
Sussex					
Hampshire					
Berkshire					
London, including parts of					
Middlesex	3,816,483	3,214	1,551	1,663	252
Surrey					
Kent					

The following statistics, showing the steady decrease of blindness in the population—the result, it is to be hoped, of improved knowledge and care in treatment of diseases of the eye of all kinds—are interesting :—

	Number of Blind	Number of Blind in one million	Number Blind of one eye
1857	18,306	1,021	979
1861	19,352	964	1,037
1871	21,590	951	1,052
1881	22,832	879	1,138

Number of blind in one million of persons of the same age :—

Age	Both Sexes	Males	Females
0	166	172	161
5	288	312	263
15	388	449	328
20	422	491	359
25	645	800	494
45	1,625	1,947	1,326
65 and above	6,715	6,897	6,929
Mean	879	953	809

These figures must, however, be regarded as only approximations to the truth, for the instructive essay of Zehender shows only too well how fallacious such statistics may be, for in the official census of Mecklenburgh-Strelitz, the number of blind persons was returned at 480, but of these Zehender ascertained that 16, or 3½ per cent., were not totally blind, whilst in Mecklenburgh-Strelitz out of 73 returned blind, 5, or 7 per cent., were not blind ; and on the other hand, in the former State 48, and in the latter 12 totally blind persons had been overlooked. The same defects of enumeration would probably be found in all censuses ; but, even if this be allowed, it is still found that, in the geographical distribution of blindness, great differences exist in different countries. Thus in Holland the proportion is only 4·45 per 10,000 ; in Austria, 5·5 in the same number ; United States, between 30° and 40° lat. 6·36, between 40° and 50° 4·65, including Canada. The author of the article 'Blindness' in the *Encyclopædia Americana* (1883), gives the proportion as 8·75 for America generally ; Switzerland, 7·61 ; Sweden, 8·05 ; Belgium, 8·1 ; France, 8·36 ; Germany, 8·79 ; England, 9·84 ; Italy, 10·15 ; Spain, 11·09 ; Hungary, 12·01 ; Norway, 13·63 ; while in Finland it reaches the number of 22·45 in every 10,000 of the population. It is somewhat remarkable that the Jews have a higher proportion of blind than the Christians, in Germany the numbers being about 8 per 10,000 amongst Christians, and about 12 per 10,000 in Jews.

Etiology of Blindness.—Blindness is more common in hot and in cold climates than in temperate, from causes that may easily be conceived. In hot climates the glare and heat of the sun, combined with the dryness of the atmosphere, the deficiency of water for purposes of ablution, the extraordinary number of flies and other insects, and perhaps the greater activity of all germs of disease, render inflammatory affections common, and every traveller notices the frequency of ophthalmic disease and of cases of blindness in Egypt, Palestine, and India. On the other hand, in the Arctic regions, and especially in Finland, where the proportion of blind persons rises to a higher number than in any other nation, blindness is of frequent occurrence, partly, no doubt, owing to exposure to cold, and the strong reflection from the surface of the snow, but chiefly owing to the unwholesome hygienic conditions that are constantly present. The huts are overcrowded ; men and animals live in close proximity with each other, and the inadequate provision for the escape of smoke, and of the exhalations from the skin, constitute precisely those conditions which every physiologist would acknowledge to be most detrimental to health, and to be exactly adapted to the production, maintenance, and propagation of disease.

M. Dumont, from an examination of the histories of upwards of 2,000 blind persons, the term being here used in the popular sense, found that the cause of blindness was : smallpox, 262 ; ophthalmia, 566 ; injuries, 181 : amaurosis, 535 ; cataract, 66 ; amaurosis and cataract (glaucoma ?), 426 ; hydrophthalmia and various other causes, 20 ; total, 2,056. Bergmeister, in his Report on the Niederöstreichische-Landes Blinden Schule in Purkersdorf, which contained 75 children (39 boys and 36 girls), states that the cause of the blindness was blennorrhœa in 12 cases = 20 per cent. ; measles in 12, congenital and hereditary blindness in 14, hydrocephalus in 7 ; other affections of the brain in 5, scarlet-fever in 6, injury in 2, Egyptian ophthalmia in 2, scrofulosis, rachitis, diphtheritis, each in 1 case, masern in 3, and there were 10 cases of doubtful origin. Of the 150 eyes in these 75 children, 95 were absolutely blind, and the remainder could distinguish between light and darkness. V. Millingen, in his

Report of his Private Dispensary at Constantinople, states that he observed 326 cases of blindness in the three years 1877, 1878, and 1879. The causes of the blindness were—Blennorrhæa-neonatorum, 4·3 per cent.; conj. gonorrhœica, 5·2 per cent.; blennorrhœa acuta, 3·4 per cent.; conj. diphtheritica crouposa, 3·6; keratitis ulcerosa, 20·7; iritis, 8·6; irido-choroiditis sympathetica, 3·7; atrophia nervi optici, 16·6; retinitis, 6·4; glaucoma, 8; retinitis albuminurica, 4·2; and the remainder from myopia, buphthalmia, microphthalmia, abscessus corneæ, keratitis bullosa, and sublatio retinæ.

Other authors, by whom the causes of blindness have been very carefully investigated, are—Schmidt Rimpler, Katz (1874), Stolte (1877), v. Zehender (1871), Seidelmann (1876), Emmert (1874), and above all by Magnus (1883) who has condensed and tabulated, as well as expressed in graphic form, the numerous observations and statistics of his predecessors. In the representation he has given of the causes of blindness in 2,528 cases, carefully examined by competent authorities, he distinguishes four classes: first, cases of congenital blindness; secondly, cases of blindness consequent on idiopathic diseases of the eyes; thirdly, blindness from injuries; and lastly, blindness occasioned by various diseases of the system at large. The particular diseases in each of the above classes, with their percentage proportion, is as follows:—

1. *In congenital blindness*, anophthalmos and microphthalmos, constituted 1·06 per cent.; megalophthalmos, 0·43; cataracta accreta congenita, 0·11; choroiditis congenita, 0·15; atrophia nervi optici, 0·75; retinitis pigmentosa, 0·75; congenital anomalies of the cornea, 0·07; congenital amaurosis from atrophy of the retina, 0·19; congenital tumours, 0·03; unnamed or indeterminate forms of disease, 0·23.

2. *Blindness from Idiopathic Diseases of the Eyes.*—Purulent ophthalmia of infants 10·87; trachoma and purulent ophthalmia of adults, 9·49; diphtheritic conjunctivitis, 0·35; diseases of the cornea, 8·06; iridochoroiditis and cyclitis, 8·86; choroiditis myopica, 0·94; various forms of choroiditis, 1·10; retinitis pigmentosa acquisita, 1·26; retinitis apoplectica, 0·11 per cent.; neuroretinitis, 0·79; sublatio retina (detachment of the retina), 4·74 per cent; glaucoma, 8·97; idiopathic atrophy of the optic nerve, 7·75; tumours of the eye and adjoining parts, 0·35; indeterminate causes, 3·36.

3. *Blindness from Injury.*—Direct injuries to the eye, 4·03: unsuccessful operations, 1·93; injuries of the head, 0·27; sympathetic ophthalmia following injury to one eye, 4·50.

4. *Blindness caused by Various Diseases.*—Syphilis, 0·47; blennorrhœa gonorrhœica, 0·91; scrofulosis, 0·03; disease of the membranes of the brain, iridochoroiditis associated with meningitis, 1·42; disease of the brain, causing atrophy of the optic nerve, 6·96; disease of the spinal cord, leading to atrophy of the optic nerve, 2·33; atrophy of the optic nerve or neuritis after hæmatemesis, 0·39; atrophy of the optic nerve, after vomiting, without discharge of blood, 0·079; atrophy of the optic nerve after hæmorrhoidal hæmorrhage, 0·039; atrophy of the optic nerve after erysipelas of the face, 0·079; atrophy of the optic nerve in insanity, 0·039; atrophy of the optic nerve in epilepsy, 0·158; atrophy of the optic nerve in dysentery, 0·029; retinitis nephritica, 0·198; cardiac disease, 0·039; pregnancy and confinement, 0·43; typhus, 0·94; measles, 0·63; scarlet fever, 0·51; small-pox, 2·21; exanthematous attacks, the nature of which is unknown, 0·23; amaurosis from intoxication, 0·03; diseases of the orbit, 0·03.

From a study of this table it will be seen that six forms of disease, the purulent ophthalmia of children, trachoma, diseases of the cornea, usually ulcerations, iridochoroiditis, glaucoma, and idiopathic atrophy of the optic nerve, constitute no less than 54 per cent. of all the causes of blindness, whilst the first two, which constitute together more than 20 per cent., may be regarded as almost, if not altogether, preventable; both arise from impurity and unwholesome hygienic conditions, and not only is the recognition of the disease at an early period in both instances easy, but the means of arresting their progress are always at hand, and can be applied with facility.

Congenital Blindness.—According to Magnus this constitutes 3·77 per cent. of all cases of blindness. It may be the result of various pathological conditions, the causes of which are not always very clearly defined. The most common conditions are either entire absence or imperfect development of the globe of the eye, which, together with congenital atrophy of the optic nerve, make up about 60 per cent. of all the cases of congenital blindness. Megalophthalmos forms 16 per cent., and the remaining 24 per cent. is made up of choroiditis and anomalies of the cornea.

Tumours of the Choroid and Indeterminate Conditions.—As might be expected from the development of the eye and adjoining parts, the globe may be defective or absent, whilst the lids, lacrymal organs, and conjunctiva may be fully formed. In many cases a cyst has been found in the orbit, and the writer has seen one case of bilateral anopthalmia in which a soft vascular mass, deeply pigmented, could be seen through the attenuated skin of the inferior lid of the left side, giving the impression that it was the displaced and partially developed choroid. Megalophthalmos, or enlargement and thinning of the coats of the eye, is probably due to intra-uterine processes of inflammation, and it has been observed as a concomitant of hydrocephalus. That heredity plays a part in the production of congenital blindness cannot be doubted after the careful consideration that Magnus has devoted to this subject. The principal constitutional diseases of the parents that lead to ophthalmic disease in the offspring are scrofulosis, tuberculosis, syphilis, and lepra. In all the inherited tendency to disease exhibits itself, particularly in low forms of inflammation of the cornea (*see* CORNEA, Inflammation of the), and the affection in the child may appear at any age between birth and fifteen or twenty years. From Magnus' observations it appear that about 23·5 per cent. of those who are the offspring of blind parents, are either born blind or have some defect of the eyes whilst the remainder have perfect vision. Dumont, however, who examined 1,168 cases of blind people in relation to this point, obtained evidence of heredity in only 68 cases, or about 5·8 per cent.; and, as in cases where the retina and its functions are at fault, there seems to be no great tendency for the same disease which is present in the parent to propagate itself to the child, but a distinct tendency to the transmission of some ocular defect.

Consanguinity.—To what extent consanguinity of the parents influences the ratio of ophthalmic disease and blindness in the children, has not been certainly determined, but there seems reason for believing that some affections—as, for example, retinitis pigmentosa—are especially liable to occur in the offspring of blood-relations. Thus, in Sämisch's clinique in the ophthalmoscopic hospital at Bonn, out of 60 cases of retinitis pigmentosa, 15 were the children of consanguineous marriages, which is undoubtedly a large proportion; and the ratio found by Leber was almost identical—18 cases in 66, the former representing 25 per cent., the latter 27 per cent. Mooren estimates it at 33 per cent., and Fienzal at 38 per cent. It may therefore be accepted as an approximation to the truth, that in about one-fourth of all cases of retinitis pigmentosa, the parents are blood-relations.

It will be seen from the above table that Magnus only admits about 11 per cent. of blindness to be due to purulent ophthalmia in Germany, and perhaps, if absolute loss of vision is considered, this may be true, but other authors, who probably use the term blindness in a less strict sense, give a far higher proportion. Thus Bourjot St. Hilaire believed that amongst the blind who presented themselves to him in the course of twenty years 27 per cent. were due to this cause. Appia found a proportion of 25 per cent. According to Claisse, amongst the 208 pupils in the Institute of Paris 95, or 46 per cent., had lost their vision from purulent ophthalmia. Reinhard, who drew his conclusions from an examination of twenty-two institutes for the blind, of which the greater number were in Germany, believed that 40 per cent. resulted from it. Lastly Daumas declared, at the Congress of Paris, that it was the cause of 69 per cent. of blindness.

The importance of the prevention of blindness, from a purely national and economic point of view, has been interestingly worked out by Magnus for Germany. He estimates the work done by each individual to be two marks per diem, or 600 marks per annum, the mark being about ten pence, and further they require for their maintenance one mark per diem; on the whole, therefore, the yearly loss to the state on each blind person is 765 marks. But in Prussia the number of blind persons is 22,677, of which, however, 2,875 have not attained their twentieth year. Putting these aside, the total annual loss to the State by the blind is about 20 million marks, or nearly a million sterling.

Preventibility.—The researches of Cohn seem to show that of 1,000 cases of blindness 238 were unavoidable, 438 were possibly preventible, and 329 were certainly preventible. It is of high importance, therefore, from every point of view, that a sound knowledge of the causation and treatment of the more important diseases of the eye leading to blindness should be taught in our hospitals and schools, made a prominent subject in all surgical and medical examinations, and in every way disseminated through the community. Much may undoubtedly be done to prevent blindness by recognising early such diseases as purulent ophthalmic trachoma, glaucoma, &c., and employing efficient treatment; and by adopting means to protect the eyes of those engaged in dangerous occupations.

Occupations suited for the Blind.—The occupations that *can* be followed by the blind are very various, about 300 being returned in the last census. Some of these are of course selected by the blind because they appear to be the best adapted to enable them to obtain a livelihood, such, for example, as basketmaking, brushmaking, bootmaking, matmaking, and music. Others show the dangers that beset certain trades and employments.

Asylums, &c.—Several of the larger cities in England contain institutions for the reception and education of the blind. Amongst the most noted of these are the blind asylums of London, Liverpool, Worcester, York, Norwich, Manchester, Bristol, Edinburgh, and Glasgow.

The first asylum for the blind in Christendom was founded by Saint Louis in 1251, and was intended to receive 300 of the poor blind of Paris, but no efforts were made for their education. In 1783, Valentin Haüy, having heard a blind pianist, Mademoiselle Paradis, who read music by means of pins, and who had learned geography by means of relief maps, conceived the happy idea of instructing other blind persons by the same method. An experiment on a boy proving satisfactory, he obtained funds from the Société Philanthropique to support twelve blind youths in a house in the Rue Notre Dame des Victoires, and the good example was soon followed in other countries.

Henry Power.

BLISTERS are subcuticular accumulations of fluid produced by an acute superficial inflammation of the skin, accompanied by effusion of serum and escape of white corpuscles beneath the cuticle, which is thereby raised up into a bleb. Blisters are met with in surgical practice as the result of burns and scalds, friction, and contusions or lacerations of deeper parts as in simple fractures, as well as from a variety of other causes; if due to inflammation alone, the effusion is serous or sero-purulent, but if there be also extravasation of blood into the limb, as in fractures, the effusion is often blood-stained.

Here we are more concerned with blisters produced by the surgeon with certain therapeutic objects, such as the relief of pain, or as a means of influencing more deeply seated inflammations, either in the way of checking them, or causing absorption of chronic inflammatory products. The most common substance used for this purpose is cantharides, either in the form of emplastrum cantharidis, liquor epispasticus, or charta epispastica. Before using either of them the skin should be well washed and dried; the length of time during which the plaster should be kept on the skin will vary, with the delicacy of it, from six to twelve hours. The liquor epispasticus is a solution of cantharidine in acetic acid and ether; it is a thick, greenish fluid, and only requires painting over the part; it is the most 'elegant' and generally useful preparation of cantharides. Blisters may be more rapidly produced by the application of chloroform in such a way as to prevent evaporation—usually on a piece of lint covered by a watch-glass, and held against the skin for a few minutes. Liquor ammoniæ fort. and the hot iron (temperature 120° F.) will produce the same effect, and the latter will do so very rapidly (10 seconds). The treatment of the blister when formed will depend on whether it is simply employed as a counter-irritant or to produce a continued discharge. In the former case the blister may be snipped here and there in dependent positions, and a pad of some antiseptic and absorbent wool applied; in the latter case the cuticle should be removed, and as soon as it can be borne the raw surface should be dressed with some irritating ointment; this is, however, a most painful procedure and one which is not often resorted to.

Bilton Pollard.

BLOOD-CYSTS. *See* Hæmatoma.

BLOODLESS METHOD OF OPERATING. *See* Esmarch's Bloodless Method.

BLOOD-LETTING, a method of treatment which, although somewhat limited in its scope in purely surgical practice, is of great service in certain cases.

Blood-letting is said to be *general* when blood is taken from a vein or artery so that the amount in the vascular system is materially diminished, as shown by diminution in the tension of the vessels; it is termed *local* when, by means of leeches, cupping, or scarification, blood is taken in smaller quantities, with a view to relieving limited congestion and vascular tension. It may be safely said that in these two methods the surgeon possesses the means of treating, in a powerful and beneficial manner, those acute inflammations and engorgements of certain important organs and serous membranes associated with hard pulse, great pain and distress, occurring from injury in persons of healthy constitutions. A point of particular importance is the aptitude possessed by blood-letting for alleviating pain and distress of the kind mentioned, as it is upon this ground, rather than upon its power as a direct antiphlogistic, that its value in surgery depends. The greater the pain and distress, the greater are the indications for the treatment.

In *general* bleeding this is well shown in cases of fractured ribs, with wound of the lung, in which the pain and dyspnœa are intense, the relief afforded by blood-letting by venesection in a full stream until the pulse is affected being most marked. An equally good result may be obtained in the same way in fractured ribs with high temperature, acute pain, and hard pulse, without lung-injury. In meningitis produced by injury, it is necessary to speak less positively; at the same time, if the disease is very acute, and the treatment adopted early, there is little doubt that, in a subject previously healthy, venesection may be practised with advantage; every care, however, should be taken to distinguish between true acute traumatic meningitis and tubercular meningitis, following on injury, in which bleeding is inadmissible.

In *local* blood-letting the same point may be illustrated. Most surgeons are familiar with the relief afforded by the application of a few leeches (from four to six) over the most painful spot on the belly in a case of acute traumatic peritonitis without visceral lesion; the same result may be obtained by similar means in nearly all cases of acute traumatic synovitis, especially of the knee-joint. So great is the relief in many such instances that the first calm sleep, ushering in recovery, follows immediately. To cases like those mentioned, blood-letting, in surgical practice proper, will for the most part be limited, and even in these the treatment, to be useful, must be applied early, when the symptoms are increasing in acuteness or remain stationary; if the climax has been reached, and the disease has assumed in the least degree the low type, the time for bleeding is gone by. One condition the surgeon may have to deal with, in which, independently of inflammation, the indication for bleeding is obvious, viz. apnœa, with great engorgement of the veins about the neck following attempts at strangulation, for it is reasonable to suppose that the removal of a few ounces of blood by opening the right external jugular vein, if done early enough, may perhaps relieve an overloaded heart so much as to enable it to resume its normal action.

Caution.—Blood-letting should not be practised without due consideration, since its effect is more than momentary, and may be followed by much depression; nor should the operator, in general bleeding, start with a fixed purpose of removing a given number of ounces of blood; but let the pulse be most carefully watched, and it will surely indicate by its diminished tension when enough has been drawn. Loss of blood is badly borne by infants, the very old, the prematurely aged, the feeble and cachectic; if, therefore, it should be necessary to take blood from such as these, let not a drop more than is really necessary be removed.

For operations for General Blood-letting, see ARTERIOTOMY; VENESECTION. *For operations for Local Blood-letting, see* CUPPING; LEECHES; SCARIFICATION.

WILLIAM H. BENNETT.

BOILS consist in a circumscribed inflammation of the skin and subjacent connective tissue, accompanied by fibrinous exudation, and usually followed by sloughing of the central portion of the parts involved, and expulsion of the slough through a small hole upon the surface.

The *causes* of boils are various and somewhat indefinite. Sometimes boils are almost epidemic, and they are generally more frequent in the spring and autumn. They are apt to attack the plethoric, as well as those who are debilitated by lactation, diabetes, or zymotic disease. Sudden changes of diet and mode of life, such as the patients of hydropathic establishments have to undergo, are apt to induce them. The same effect is observed in young servants, and in youths training for athletic sports, where the changed conditions are accompanied by a more liberal supply of meat. The affection has also been noticed to attack with great violence those who have eaten the flesh of diseased animals. They are not infrequent among medical students who breathe the vitiated air of dissecting and post-mortem rooms. Where there is already a constitutional predisposition, the exact site is often determined by some local irritation, such as the friction of the nates in rowing, the pressure of certain articles of dress, the application of a poultice or plaster. They may also be set up by the absorption of putrid matters through the skin, and from this cause those engaged in pathological work frequently suffer from boils upon the back of the hands or wrists.

Symptoms and Course.—Boils may be single or multiple, and they may occur successively in different parts of the body. An itching spot appears usually at the opening of a hair-follicle, and soon develops into a small red lump. This is frequently surmounted by a vesicle or pustule, which bursts or dries up. As it grows, the swelling becomes of a bluntly conical shape, tender, painful, and of a bright red colour. At first it is hard, but it soon begins to soften, and the pain becomes of a more throbbing character. In a few days an opening forms at the summit, and some pus is discharged. At the bottom of the opening is seen a yellowish mass, consisting of a slough of fibrous tissue infiltrated with lymph. This—the so-called *core*—after a few hours escapes through the opening, and leaves a flask-shaped cavity, which contracts and fills with granulations. In a day or two it heals, and a small scar is left upon the skin. Another variety, called the *blind* boil, is less elevated and more diffused. It is slow to discharge itself, or it may remain as a firm indolent swelling for several weeks, and then undergo resolution without any suppuration.

There is usually but little constitutional disturbance in those affected with boils. A slight chilliness, with a transient feeling of malaise and irritability, may accompany the onset, but afterwards the only trouble is that caused by the local pain. When, however, they occur in already debilitated patients, the symptoms may partake of a hectic or even typhoid character; and cases are on record in which the disease has proved fatal by the supervention of pyæmia.

The inflammation attacks more especially the sebaceous follicles of the hair-bulbs. Boils, therefore, are not found in parts in which these structures are absent, such as the palms and soles. When they occur in the follicles of the eyelashes, they are called *styes.* They may also attack the ceruminous glands of the ear, and sometimes they affect the sweat-glands, especially those of the axilla.

Diagnosis.—The red, indurated, and tender base, which is large in proportion to the small pustule at the apex, will distinguish boils from impetigo, ecthyma, or the blebs which sometimes follow poisoned wounds of the skin. Carbuncle, a closely allied affection, is easy to recognise by its larger size, more flattened surface, and the numerous apertures which lead down to the central slough. Malignant pustules are usually confined to those who have been exposed to the specific contagion of that disease, and the absence of pain, together with the peculiar character of the eschar, will be sufficient to lead to their identification. The gummata of syphilitic or tubercular patients occasionally resemble boils, but they may generally be known by their attacking chiefly the subcutaneous tissues, and by their bursting with a larger external opening.

Treatment.—The patient should take a plain nutritious diet, with only a moderate quantity of animal food. Unless there is much debility, there is no advantage in the use of alcoholic stimulants. He may take sulphate of quinine three times a day, in 2-grain doses, with a grain of sulphate of iron, and from 5 to 10 drops of dilute sulphuric acid, accompanied by ʒss. of sulphate of magnesia if the bowels be not well opened. The administration of as large quantities of quinine as can be borne without cinchonism has sometimes proved beneficial. Sulphide of calcium, in $\frac{1}{6}$-grain doses every hour or two, has been recommended; and some cases improve rapidly under the administration of yeast in doses of a tablespoonful three times a day, half an hour before meals. A change of air often succeeds where other remedies have failed.

For local treatment the boil may be covered upon its first appearance with a thick layer of collodion, or it may be touched with nitrate of silver. The extract of belladonna alone, or in combination with an equal quantity of glycerine, is also a good application in the early stage. Later on, considerable relief is afforded by a linseed meal poultice, but as there is some risk of irritating the adjacent skin, and setting up fresh boils by this remedy, it is well to sprinkle it with olive oil, or the dilute solution of the subacetate of lead, before putting it on the boil. When these applications are inconvenient, the elevation may be protected by a covering of plaster spread on soft leather, in which a hole should first be punched at a point corresponding to the apex of the boil. It is only in cases in which the pus is very slow in reaching the surface that an incision is required; and then it should only be a deep vertical puncture in the centre of the boil, made with a narrow double-edged knife.

N. Davies-Colley.

BONE, Diseases of.—The various forms of disease which attack the human skeleton are the same in kind as those which are seen in the soft parts, modified of course by the anatomical and physical peculiarities of the bony structure. The slowness with which the morbid changes are effected is one of its striking peculiarities. Consequently amongst diseases of bone we find some of the most chronic disorders from which the human body is capable of suffering. If, as in some of the acute inflammatory affections, rapidity of action should ensue, the death of the part involved is the usual termination. Although so slow in exhibiting pathological change, bone is nevertheless capable of the most perfect repair. Although slowly, it produces granulations as readily as any other tissue of the body, and, provided its vascular connections have not been completely annihilated, the bone is reproduced almost in its original form. Its rigid and inelastic structure is no doubt the reason for the frequency of necrosis, and the inability of the veins of the medullary canal to collapse from the same cause, coupled with the absence of valves, is undoubtedly the origin of the pyæmia and septicæmia so frequently seen in inflammatory affections of bone, in the days when decomposition of the discharges was not prevented by suitable antiseptic precautions.

The diagnosis of bone-disease, i.e. of bone being the part affected in any given swelling, must first engage our attention. The freedom of other, and especially the superficial structures, is the most important negative evidence. In infiltrating and inflammatory swellings, however, the soft tissues are sometimes very rapidly involved, and then we have to rely upon other symptoms for the diagnosis. Generally we are able to say that the bone itself feels enlarged, or that the tumour or swelling is fixed and attached to bone; and if the superficial structures are engaged, we are often able to obtain evidence of pain and tenderness having been felt before the external parts exhibited any swelling. In most of the diseases of bone, however, the first and most important symptom is an enlargement which is quite clearly deep-seated. The patient usually complains of a dull, aching pain, which is especially troublesome at night on getting warm in bed, and keeps him awake for many hours. The pain is scarcely ever acute, and is sometimes the only symptom of which complaint is made. A sense of increased weight is also occasionally felt.

The differential diagnosis between the various affections of bone has next to be considered. The patient's history may often be of great service, first, as to the possibility of the disease being due to accidental causes; but even here there may be exceptions of considerable importance, e.g. acute diffuse periostitis often has a history of some slight and trivial accident preceding the onset of the symptoms of inflammation. So much is this the case that some surgeons look for and expect to find a history of injury in almost all cases of diffuse inflammation of periosteum. Again, in sarcoma of bone it is not uncommon to have a history of injury of considerable severity, and, within a very short time of the accident, a tumour is discovered in the part injured. This form of tumour has lately been dignified with the name of 'acute traumatic malignancy.'

It is well to bear in mind that ostitis, periostitis, and osteomyelitis, are so intimately united, both in their pathology and in their clinical symptoms, as to be occasionally confounded with one another. Almost every inflammation of bone, of whatever kind, is at times spoken of as periostitis, whereas the periosteum has, in most of such cases, only been secondarily involved, ostitis or osteomyelitis being the primary condition. The cases in which the periosteum is primarily or principally involved are, however, sufficiently distinct; and there should be no difficulty, at any rate, in distinguishing the cases of periostitis when this membrane is alone affected. *See* PERIOSTITIS. Acute inflammations of the bone, periosteum, or medulla, taken as a group, are readily separated from the other diseases of bone by the suddenness of the attack and the acuteness of the process of inflammation. The history also of a previous illness, such as one of the specific fevers, or the occurrence of a slight and trivial accident in a young subject, would be additional evidence in favour of this view of the case.

The chronic diseases may present a little more difficulty. The patient can scarcely say when the affection began. He may have suffered pain at night for some months; or when first his attention was directed to the part of which he complains, the state of things may have been in the same condition as at the time when he asks your advice. In the one case a history of long-preceding pain would point to chronic inflammation of bone; and in the other, the presence of an enlargement which, when first noticed, was of such a size as to lead him to seek advice for that alone, would indicate a new growth such as an exostosis, or possibly a sarcoma of bone. But an examination will probably at once clear up the difficulty. The first point necessary to ascertain is the presence or absence of inflammation. This will be decided on ordinary grounds which we need not here discuss. The acute inflammatory affections have been already mentioned, and will be further described, each in detail, under their appropriate titles. The symptoms of subacute or chronic inflammation might perchance be mistaken for those of a sarcoma of bone. They are both infiltrating in character: both may feel hot and inflamed to the hand: both may be either endosteal or periosteal. The question naturally arises, Does the swelling fluctuate? is it solid or fluid? If it be dense and solid throughout, and occupy nearly the whole shaft of a long bone which seems to be uniformly enlarged throughout its whole length, there can be no difficulty in ascribing it to chronic ostitis. But if the swelling occupy one end of a long bone, and if that should be the lower end of femur or head of tibia, the case may present greater difficulties. Clearly, if fluctuation be detected, and the fluid seem quite close to the surface, the case will probably be one of abscess, and if the bone is much enlarged all round that part of its circumference, the pus will, in all probability, be due to inflammation of the cancellous tissue. More commonly, however, the pus has not thus made its way to the surface, and its presence is only detected by the excessive tenderness which is exhibited on pressure at one spot. For further information, *see* ABSCESS OF BONE.

New growth affecting the same part may also give rise to an elastic feeling very closely resembling fluctuation. But the tumour generally presents greater irregularity of outline, and varies considerably in its elasticity and resistance to pressure in different parts. In the periosteal sarcoma, the growth will probably be situated on one side, whilst in the central or endosteal form of tumour the whole outline of the bone, at the part affected, will be lost: and, in addition, such unmistakable evidence of its nature as 'egg-shell crackling' and pulsation may possibly be obtained. A sarcoma affecting the centre of the shaft of a long bone is at first often fusiform in shape, but rapidly assumes much larger dimensions than any chronic inflammation would produce; and, if endosteal, it is not infrequently indicated by spontaneous fracture. *See* TUMOURS OF BONE.

An exostosis requires very little explanation. It is generally a pedunculated growth of small size, attached by preference to the bone in the neighbourhood of epiphyseal lines, and starting into existence about the age of puberty. On examination it is not uncommon to find more than one, or even a considerable number, in different parts of the body. Further details will be found under EXOSTOSIS.

The osseous deformities of rickets and congenital syphilis will be found described in the articles on those diseases. Softening of bone and spontaneous fractures will be found described under OSTEOMALACIA and FRAGILITAS OSSIUM. The curvatures of the long bones, especially those of the lower extremities, which occur in old age, and are attended with a large development of osteoporotic new bone, both in the long bones which are deformed and in the skull, will be found described under OSTITIS DEFORMANS. If a sinus should exist when the case first comes under observation, the surgeon is referred for information to the articles on CARIES and NECROSIS.

The constitutional condition of the patient may throw some light upon the nature of the disease, and should be carefully considered in relation to the various affections which have been named. High fever may be expected in cases of acute diffuse periostitis and osteomyelitis. If of recent origin and considerable intensity, and the local symptoms bear out this conclusion, the information gained by the thermometer will give great precision to the diagnosis. Hectic fever also may be observed in these cases when the disease is of some duration; and its presence or absence may aid the surgeon considerably in forming an opinion as to the prognosis. But the general condition of the patient, his tolerance of the constitutional and local disturbance which he is undergoing, and the probable duration of the disease, should have due weight in estimating the chances of recovery.

Of all the constitutional diseases, syphilis is the most important to recognise, and should always be looked for in subacute and chronic cases. The periosteal nodes generally appear during the early stages of this disease, so that one may expect to find some other evidence of syphilis, either in the throat, on the skin, or in the glands. This is of importance, as it will lead the surgeon to place the patient under the influence of mercury, after having relieved the painful nodes by iodide of potassium. In enlarged and thickened bone, such as osteosclerosis, in gummatous periostitis, and in intractable ulceration of bone, sometimes called syphilitic caries, a history of the disease should, if possible, be obtained, as it enables the surgeon to treat the constitutional affection with greater confidence. But too much reliance must not be placed on the absence of such a history, for experience teaches us that many cases must be classed as syphilitic on account of their exact similarity both in the course they run, the prognosis that must be given, and in the treatment that is essential for their cure, although the history of the disease be decidedly deficient in many of its most salient features. Many cases of ostitis that were formerly looked upon as strumous, are now regarded as due to congenital syphilis. They occur generally in the middle of the shaft of a long bone, such as the tibia, about the age of puberty, and are exceedingly chronic. Confirmation of the diagnosis should be looked for in the eyes, teeth, and physiognomy of the patient, and if possible the brothers and sisters should be examined in the same way, as in suspected cases of congenital syphilis. The epiphysitis that occurs somewhat earlier in the history of such patients might possibly be confounded with rickets, but this has received full attention in the article on diseases of the epiphyses.

Struma and tubercle must also receive their .share of attention in the chronic, slowly suppurating, diseases of bone, such as caries and chronic abscess. It is unnecessary to point out here the way in which this is to be done. The history and physical examination may indicate pretty clearly that the patient is predisposed to these affections. H. H. Clutton.

BONE-GRAFTING. *See* Grafting.

BONE-SETTING.—The term 'bone-setting' was first applied to the proceedings of certain irregular practitioners, who flourished chiefly—so far as this country is concerned—in the North of England, and who were accustomed to treat by rough manipulation, and frequently to cure, joints which had been left in a disabled condition either by disease or by injury. Their manipulation was commonly attended by the production of sound, which the operators would explain to be the noise made by a displaced bone in the act of returning to its socket; and they were, as a rule, sufficiently ignorant to believe this explanation themselves, as well as sufficiently earnest to succeed in imposing it upon their patients. Hence, when a joint which had been under medical treatment, and remained crippled in spite of it, was cured by the handling of a 'bone-setter,' he would say, and the patient and his neighbours would believe, that the doctor had overlooked a dislocation. Of late years the whole subject has been carefully studied by surgeons, instead of being, as formerly, pooh-poohed by them. It has been found that in a very large number of cases of injury, and in some cases of disease, the rest which commonly forms part of the treatment, produces an injurious effect, as well as a beneficial one; and that it leads to the formation of adhesions, either within or around the affected joint, by which its mobility is impaired. The formation of such adhesions may sometimes be prevented by early recourse to passive, or even active, motion; but, if once formed, they can only be got rid of by tearing. In the course of the necessary manipulation they yield with a distinct sound, for which the original bone-setter was always on the watch; and the old term has been retained, as affording a convenient expression for the modern practice. The bone-setting of the surgeon differs from that of the quack, to the extent that the former understands the pathology of the cases to which it is applied, and confines its application to those in which it is needed and is calculated to be useful.

It will be convenient to consider first the conditions which call for the employment of bone-setting, and these are all forms of partial ankylosis. The cause of the partial ankylosis may be either disease or injury of the affected joint, or of some parts contiguous to it; the effects of such disease or injury being aggravated by prolonged abstention from movement, and the ankylosis itself not coming into prominence until the endeavour to move the joint is resumed.

The pathology of these cases is to some extent conjectural, since they rarely become the subjects of post-mortem examination; but there can be no doubt that conjecture and analogy are sufficient to afford correct notions of the conditions which commonly exist.

The occurrence of inflammatory (i.e. rheumatic or pyæmic) mischief in a joint, an actual injury, such as a sprain, befalling it, or the fracture of the shaft of one of the bones entering into its formation, are, all of them, conditions which have been customarily treated by enforced rest and restraining apparatus. The rest itself, and the pressure of the apparatus, combine to promote the exudation of more or less plastic fluid from the blood-vessels; an exudation which will, of course, be still further promoted, and be rendered more highly plastic, when the joint-structures are themselves affected. The exudation may occur within or around the cavity of the joint, within or around the sheaths of the neighbouring tendons, or it may be more widely diffused among surrounding structures. The tendency is to consolidate and contract, to glue together the adjacent folds of synovial membranes, to unite tendons to the sheaths in which they should move freely, to permeate and condense inter-muscular and superficial connective tissue, to compress blood-vessels, and generally to arrest movement and to diminish functional and nutritive activity.

The impediments to movement are strictly mechanical; and hence, when these impediments produce traction on parts which are not normally adherent, the traction is apt to be painful, and may be followed by increased swelling, by tenderness, or by other signs of increased local inflammation.

The *symptoms* are, that a joint which has been subjected to any of the incidents above mentioned, which has been inflamed, or injured, or long restrained from movement by reason of a neighbouring fracture, does not recover its mobility. It can usually be moved to some extent, but its movements are limited, and any attempt to transgress these limits is attended by pain, and is often followed by fresh evidence of active mischief. It is frequently possible to discover by pressure some spot which is acutely tender. The joint is usually somewhat swollen, the skin covering it more or less congested, glossy, or tumid; and the muscles of the limb are wasted in a degree corresponding with the length of time during which they have been inactive.

The *treatment* must be considered under two heads; first, with reference to the cure of the above-described conditions; secondly, with reference to the means by which their occurrence may be prevented.

For the cure there is only one available method, namely, rupture by manipulation of all adhesions which impede movement. Experience has abundantly proved that, although the mere extension of the adhesions gives much pain, and sometimes excites fresh inflammation, the complete rupture of them by a single movement is not more painful in the first instance, and is never followed by any subsequent trouble. Unless in very slight cases, a patient for whom it is proposed to break down adhesions should always be placed fully under the influence of an anæsthetic. The question of pain is only a secondary one, and the majority of people would have sufficient fortitude to bear the operation; but it is highly important to overcome the instinctive resistance of opposing muscles; and it is almost equally so to allow the surgeon to proceed with deliberation and care, feeling his way as he goes, and not desisting until the complete range of mobility is restored. It must be remembered that a certain knack is required in breaking adhesions, and that different joints require somewhat different handling, the details of which it would be difficult to convey without the aid of illustrations. In the last four or five years much has been written on the subject, and, among others, the writer has given the necessary illustrations, and full verbal descriptions of them, in his work on ‘Bone-setting (so-called).’

When adhesions have been broken, the most important part of the after-treatment is that the joint should be taken into use immediately. Supposing the knee to have been affected, the patient should be made to bend it freely, and to put down the foot and walk on the same day, and every day afterwards until the cure is complete. Any return to splints or bandages, or to enforced rest, will certainly be followed by reunion of the adhesions, and by renewed incapacity.

Under the influence of functional use, the swelling around the joints will gradually disappear, the muscles will recover their tone and vigour, and the old troubles will be forgotten; although, of course, time will be required for the full completion of reparative changes. But, if the operation of breaking the adhesions is followed by inaction, all that is gained at the time will be lost, and the treatment will have to be repeated before a cure will be obtained. It is hardly necessary to say that, especially in cases of long standing, recovery may be much promoted, after the adhesions are broken, by the diligent use of passive movement, by frictions, and by the more skilled forms of friction which are known as shampooing or massage. These, however, must be auxiliary to the movements effected by the patient, and must not be expected to supersede or to replace them.

It is not unnatural that surgeons, who have seen the recurrence of inflammation which is apt to be produced by the slight extension of joint-adhesions, should fear to permit free movement immediately after adhesions are broken. Reflection will show that the two conditions have nothing in common. The inflammation following slight extension was due to the drag of the stretched adhesions on neighbouring parts; but, by the complete rupture of the adhesions, all possibility of dragging is taken away. In considering the means by which partial ankylosis may be prevented, it is needful for the surgeon to clear his mind of one of the ancient traditions of his art, and to realise the fact that 'rest,' although sometimes a necessary part of treatment, is at best a necessary evil, not to be resorted to without necessity, and not to be continued a day after it can be dispensed with.

In some cases of fracture, enforced rest of the neighbouring joints is imperatively necessary; but, even then, the surgeon should never forget the consequences which this rest may produce, and should be on the watch to employ passive movement at the earliest possible time.

In cases of another class, in which rest is commonly employed, it is from the first not only unnecessary, but always and actively injurious. Sprains of every description, and accidental ruptures of muscular fibres during effort, should be treated by strapping and bandaging, and the moderate use of the affected limb should not be interfered with.

When this method is pursued, a short time will suffice for complete recovery from an injury which, if treated by the old plan of rest and fomentations, would mean imprisonment to a bed or sofa for weeks, probably followed by permanent diminution of strength and usefulness.

Wharton Hood.

BOUGIES—so called because wax tapers (bougies) were at first generally, and are still occasionally, used for the purpose—are supple instruments for passing along the gullet, rectum, or urethra, to widen those passages when narrowed. They vary in length and size, to suit the different canals they are to traverse, being about 2 feet long for the gullet, 8 or 9 inches for the rectum, and 13 inches for the urethra. Their thickness varies also greatly, and is measured in this country by scales which vary with different makers. The French scale, which is generally adopted on the Continent and in America, and is coming into usage here, enlarges by equal increments, each size being 1 millimetre larger than the preceding one. Those used for the urethra are made in three forms, of which there are several varieties, and range from 1 millimetre to 40 millimetres in circumference. The 'English' or 'gum elastic' bougie, of tawny brown colour, is made of a seamless tube of silk woven like a stocking. Several coats of copal varnish are laid on until a fine smooth surface is obtained. This bougie is cylindrical, of the same thickness throughout, rigid when cold, but pliant when warmed to the temperature of the body. If kept bent for several weeks it takes a 'set' which it is slow to lose. If well made it is tough and durable even when rigid, but if badly made the English bougie is apt to snap if bent suddenly.

The French bougie is more flexible than the English; it is similarly woven of silk, but the shape is better adapted to pass along the urethra. It is covered with black varnish. The full width of the bougie reaches to about the lower third; from thence to the point the bougie tapers gradually, and is very pliant near the tip. When the tip is a little bulbous the bougie is called 'olivary,' but this form is also made to taper to a moderately fine point without a bulb. In a well-shaped olivary bougie the 'swell' of the tip is just sufficient to remove all sharpness from it, and the tapering end itself is so supple that it bends easily if the tip catches in an obstruction. This pliancy diverts the point and lets it slip past the obstacle. The tapering bougie is less durable than the English 'gum elastic' one, especially if really made in France, for the imported ones are not so well varnished or so tough and smooth as those of English manufacture. But the genuine French article is the better shaped: the English imitation often does not taper rapidly enough; the point is stiff, and cannot yield at once to an obstruction. Again, the olive of the tip is apt to be too large, and form a real boss as thick or thicker than the widest part of the bougie. The flexibility of the tapering bougie has been modified by the introduction of leaden stylets, themselves tapered to a fine point that penetrates to the tip of the bougie. Instead of a wire stylet, the bougie may be filled with fine shot. By either plan the instrument may be bent to any curve, and will keep the curve while it is being passed along the passage. Bullet bougies (*bougies à boule*) are used for exploring canals. They consist of a slender tubular stem, to which the necessary stiffness is given by inserting a leaden wire into it. The stem ends in an egg-shaped bulb. In these bougies the stem remains of the same thickness, while the bullets range in circumference from 8 millimetres to 40 millimetres. The stem may be usefully marked at each inch from the bullet with a ring, the ring at the fifth inch in urethral bougies being broader than the rest, to serve as a landmark from which to count.

For passing through strictures too narrow for woven bougies, others of whalebone, catgut, and silkworm gut are used. Whalebone is troublesome from its rigidity, but that can be lessened by steeping the bougie in boiling water. Catgut is apt to get rough, and, after soaking for a short time in the mucus of the urethra, it becomes inconveniently supple. Silkworm gut is very strong, very fine, and not affected by urine or water. It is therefore preferable where bougies of moderate length and great tenuity are required. Bougies made of a new material, 'celluloid,' have been recently patented. They are non-absorbent, very smooth, and pliant when heated, but resume their rigidity too quickly to be generally useful for bougies. When cold the celluloid is sometimes very brittle. These qualities render this material of limited use for bougies, but for catheters for tying in the urethra celluloid is well fitted. It remains perfectly unaffected, however long it is worn, and unirritating, because at the temperature of the body it yields to the curves of the passage in which it lies. *See* CATHETERS. BERKELEY HILL.

BOUTONNIÈRE, the Operation of.—This term has been applied to an incision made in the perineum in the treatment of urethral strictures, which has been known by many appellations. As the name '*boutonnière*' suggests, the incision is a small one made in the mesial line of the perineum, and resembles a button-hole. The operation is an ancient one, and has been practised in various ways both in England and France for centuries. In modern surgery there are three modifications of it, or, rather, it is practised to serve three purposes:—1st. To expose the anterior end of the stricture of the urethra through which an instrument cannot be passed by way of the meatus, in order to divide the stricture from before backwards. 2nd. Also in cases of impassable stricture, to open the urethra behind the stricture, either to relieve retention of urine, or to give the bladder and stricture rest from the irritation caused by the straining necessary to force urine along a very narrow passage. The stricture, of course, would be dealt with by subsequent operation. 3rd. When disease of the bladder is present, for which digital exploration of the mucous surface is required, or when it is necessary to maintain free drainage of the bladder and the presence of an instrument cannot be borne.

1. The first variety of the operation—to get at the anterior orifice of, and thereby pass along the stricture a guide upon which the knife may divide the fibrous tissue that causes the contraction—is best performed by the method known as Wheelhouse's. The patient being anæsthetised and in the position for lithotomy, the operator passes along the urethra, from the meatus to the stricture, a straight steel staff 4 or 5 millimetres in circumference, 11 inches long, and grooved on one side. The beak is turned into a blunt knob or hook towards the side opposite the groove. With the groove directed towards the surface the staff is pressed forwards in the perineum until it can be readily felt from without. While the staff is held steady by an assistant, a vertical cut is made in the mesial line by the surgeon, large enough to allow the beak of the staff being thrust through the wound. The staff is then turned, that its knob may catch in the anterior end of the incision, which is tightened and fixed by the assistant, who pulls it steadily upward. The operator continues his incision in the mesial line backwards towards or over the stricture for about one inch, dividing the urethra freely opposite the anterior end of the stricture. By a hooked forceps applied on either side, the margins of the incision are drawn apart, and the interior of the urethra is exposed opposite the mouth of the stricture. This opening is carefully sought for, and, when found, a grooved director, with a fine tapering point, is insinuated through the stricture to the bladder. The point of the knife being then entered in the groove of the director, its edge is carried backwards till the stricture is thoroughly divided. The knife is laid aside, and a small tapering gorget, with a beak that will run along the groove of the director, is passed to the bladder. When the gorget has reached the bladder the director is withdrawn, and a flexible catheter, introduced by the meatus into the anterior part, is guided along the deeper part of the urethra by the gorget. The catheter being fixed in the bladder, the gorget is withdrawn, and the operation is completed.

2. By the second method—known as 'Cock's operation,' from its having been frequently practised and its value demonstrated by the eminent surgeon of that name—the urethra is reached in its membranous portion behind the stricture, at a point where it is usually dilated and more easily recognised than in the healthy state. Like the first form of boutonnière just described, this operation is adopted only when an instrument cannot be guided along the urethra to the bladder. The part of the urethra

attacked in the operation is that between the bulb and the prostate. The finger, with its tip just within the margin of the anus, feels the anterior or lower surface of the prostate, and informs the operator of the posterior limit of the membranous portion of the urethra. The central point of the perineum, being just behind the bulb of the corpus spongiosum, gives, for the purposes of the operation, the anterior limit. The knife, held with its cutting edge forward, is entered in the *raphé* of the perineum three-fourths of an inch in front of the anus, and a cut made through the integuments about half an inch long and half an inch deep. The tip of the finger inserted into the wound enters the small conical interval between the anterior wall of the rectum and the membranous part of the urethra. In cases of retention of urine the urethra, dilated at this point, can often be distinguished, and projects in a condition which facilitates the remainder of the operation. The operator, using the finger as a guide, pushes the knife cautiously upwards and backwards into the urethra. The gush of urine that escapes proves the urethra to have been opened, and the finger may then enter it and pass to the neck of the bladder, serving as a guide for introducing a catheter. This completes the operation.

3. In the third variety the operation is extremely simple. A curved lithotomy staff, having the groove on the centre of the convexity, not on the left side, is passed to the bladder and held steadily while the surgeon, pushing the knife on to the staff just behind the bulb, cuts for one inch or three-quarters of an inch towards the anus. This affords an aperture large enough for the finger to enter and pass into the bladder and search the whole of the interior, and ascertain the position, size, and shape of tumours or other affections of that organ. BERKELEY HILL.

BOW-LEG may make its appearance before a child's feet have been put to the ground, in which case it is simply an exaggeration of the natural curve of the tibia under the influence of muscular contraction. Or it may be the effect of that peculiar habit which the rickety child possesses of folding its legs across each other and sitting upon them tailor-wise. Often this condition of leg is associated with an exaggeration of the natural outward bowing of the femur, in which circumstances genu extrorsum (q.v.) is the result. Sometimes one leg is bandy whilst the other is in-kneed. This is caused by the mother or nurse carrying a soft-boned child always upon the same arm, whilst with the other she clasps the child's legs across the front of her body. Thus, if she carry the child always upon her left arm, the right knee will become valgous, whilst the tibia of the other leg will become moulded against the valgous knee, and consequently bandy.

Treatment should be begun as soon as the existence of the deformity is recognised. If the child be badly nourished or rickety, he should be carefully tended as regards feeding and clothing; warm stockings or woollen gaiters should be advised, with the view of keeping up an even circulation in the legs. If, when the child is being carried or wheeled out in the open air, the feet and legs become chilled, the nutrition of the bones must necessarily be seriously interfered with. Frictions in the direction of the venous and lymphatic return should be employed morning and evening after the warm bath, and if the patient be flabby, weakly, or ill-nourished, not only his legs but his entire body may be rubbed with cod-liver oil. A large proportion of those with bent legs have been brought up upon the bottle, and many of them reared upon condensed milk or a farinaceous diet; fresh milk, eggs, and meat will be wanted, but no tea, beer, or wine. If the treatment thus briefly sketched out be adopted, and the child be taken entirely off its feet, a slow but steady improvement will set in; but if the deformity be already considerable, it will be well to adopt accessory measures. Thus, a light wooden splint, padded on each side, may be fixed between the limbs, and the legs be bandaged to it. The splint should be long enough to reach some inches below the level of the feet, so that the child may be unable to stand, for, whatever be the treatment adopted, no weight must be transmitted through the leg-bones. To apply splints of wood or iron, and then allow the child to walk about, is manifestly wrong.

Children do not fret when they are made to keep off their feet, nor does their health suffer from the enforced rest. If only one leg be bowed, it should be bandaged to a long inside splint, so as to insure rest. The improved condition of the bone is obtained more by rest being insured, than by the mechanical effect of the bandaging. Some years ago the writer had under his care a little girl with extremely marked bowing of both legs; one leg he treated by forcible straightening under chloroform, the other he let alone. The child was taken completely off her feet, and at the end of a year the bandiness had almost entirely disappeared from both legs; the rest which had been necessary for the limb which had been forcibly straightened, had induced an equal improvement in the other. It may be well to note that the use of a Martin's bandage with the splint is apt to cause cellulitis, ulcerations, or even sloughing; and that in forcible straightening of the limb care is required, lest the epiphysial cartilages be torn through. Osteotomy for the bandy legs of little children must be very rarely necessary. Edmund Owen.

BOZEMAN'S OPERATION is an operation for ruptured female perineum, in which metal plates and wires are employed. *See* Perineum, Rupture of the.

BRACHIAL ARTERY, The, commences at the lower border of the teres major, and passes downwards and forwards along the inner bicipital groove until it reaches its bifurcation, one inch below the elbow.

In front are—the skin: the superficial fascia with cutaneous nerves therein: the basilic vein: the median basilic vein at the elbow: the deep fascia: the bicipital fascia at the elbow: the median nerve, crossing it half-way down the arm. Behind it are—the long and inner heads of the triceps, the insertion of the coraco-brachialis, the brachialis anticus, and the musculo-spiral nerve. Internally it has the ulnar nerve at its upper part, the median below. Externally the coraco-brachialis muscle, the external cutaneous nerve, and the outer head of the median at the upper part, the biceps below.

Ligation.—(1) In the upper third the steps of the operation are as for ligature of the axillary artery in the third stage, the basilic vein appearing in the wound in place of the axillary. (2) In the middle of the arm, place the patient on his back, with the arm abducted at a right angle and rotated outward. Make an incision in the line of the artery two inches long. Cut through the cutaneous structures, expose the inner edge of the biceps, and then draw the muscle gently outwards, when the median nerve will be seen lying on the artery. Detach the nerve and pull it inwards or outwards, the former the better; open the sheath, avoid the venæ comites, and pass the needle from without inwards, having the arm slightly flexed at the time. (3) In the lower third—i.e. at the bend of the elbow—the artery lies between the tendon of the biceps, externally, and the pronator radii teres internally. It has the median basilic vein and the bicipital fascia in front, and the median nerve to the inner side. With the arm abducted and rotated outwards, make an incision $1\frac{1}{2}$ inches long over the course of the artery, and immediately ($\frac{1}{8}$th of an inch) internal to the tendon of the biceps. Pull the median basilic vein and the internal cutaneous nerve inwards: cut through the bicipital fascia, when the artery is found surrounded by venæ comites, having the biceps one-third of an inch to its outer side, the median nerve one-third of an inch to its inner side, and the brachialis anticus behind.

James Cantlie.

BRACHYMETROPIA. *See* Myopia.

BRAIN, Abscess of the. *See* Encephalitis.

BRAIN, Compression of the.—Compression arises from pressure on the brain. It may be brought about in many ways, such as by depressed bone, intracranial hæmorrhage, accumulation of inflammatory products, tumours, syphilitic and tubercular deposits, cerebrospinal fluid in undue quantity, &c. Intracranial hæmorrhage is by far the most common cause of compression; especially is this the case if idiopathic apoplexy, which is generally central, be included along with that occurring from traumatism, which is usually peripheral. Paralysis is its most definite indication.

Diagnosis.—The symptoms are dependent upon the amount of the pressure, and the rapidity and rate at which it occurs. Small effusions of blood, and slight osseous depressions, may take place without giving rise to any distinct symptoms. It is believed that blood may be slowly effused upon the surface of the brain without giving rise to any definite indications of its presence. Rapid extravasation, on the other hand, produces symptoms of marked compression. In a typical case of compression, the following are the general symptoms:—The patient is comatose, breathing is slow and laboured, often stertorous, and in some cases this is accompanied by a peculiar puffing arising from complete facial paralysis; there is retention of urine, which, if unrelieved, ends in incontinence from overflow. The pupils may either be contracted or dilated; they are often unequal, and they are usually fixed, not responding to light. The surface of the body, though it be at first cool, soon becomes hot, and often it is bathed in perspiration.

Though these are the symptoms recognised as typical of compression, it must not be understood that they are present in all cases. In localised compression the paralysis is only partial, and corresponds to the affected region. There may be paralysis of one side of the body, with loss of consciousness; or of one limb, or only of the muscles supplied by certain nerves, without loss of consciousness. There may also be mental confusion or delirium. One pupil alone may be affected, the other remaining quite normal.

The order of the symptoms is important, helping to differentiate the various causes of compression. When depressed bone is the cause, the symptoms follow immediately after the accident. When due to intracranial hæmorrhage, especially when this takes place outside the membranes, there is generally an interval before the symptoms set in. When inflammatory effusion takes place, the symptoms are gradually developed, and are ushered in by a series of phenomena, such as increased temperature and general febrile disturbance. When pus forms between the dura mater and the bone, as the result of traumatism, it takes place one or more weeks after the injury. In tumours the symptoms are generally very slowly developed. When the effusion of blood is so great as to exercise pressure on the brain generally, there will be in most cases no symptoms indicating the locality of the effusion. But when sufficient pressure affects a part of the brain only, localising symptoms may be looked for.

INTRACRANIAL EFFUSIONS OF BLOOD may take place outside the dura mater; into the cavity of the arachnoid; into the pia mater; and into the substance of the brain, or one of its ventricles. When the out-pouring of blood into any of these positions arises from traumatic causes, the symptoms occur slowly, and an interval of time generally elapses between the accident and the occurrence of the symptoms, though this may not be evident when insensibility ensues from concussion, or when compression is induced by depressed fracture. By reference to the symptoms alone, it is difficult and frequently impossible to differentiate between blood poured out on the exterior of the dura mater and on the surface of the brain, especially when the amount of the effusion is great. But when there is an external injury of limited extent, the probability is that the blood is superficial. When there is evidence of contusion or laceration of the cerebral substance, extravasation of blood into the brain-tissue will have occurred at that point.

Extravasation on the *outside of the dura mater* may take place from the rupture of minute vessels which pass between the skull and that membrane; or from large vessels which lie in the osseous grooves in the interior of the skull. When it arises from the former, the extravasation is not extensive, and seldom causes marked symptoms; if from the latter, the amount of blood effused is great, and separates the dura mater from the skull, often to a considerable extent; at the same time it causes, by its pressure, marked depression of the cerebral substance. The vessel most frequently found ruptured from traumatic causes is the middle meningeal, or one of its branches. In fractures of the middle fossa, this vessel may be ruptured at any part of its course from the foramen spinosum to the anterior inferior angle of the parietal. The blood may, however, come from one of the sinuses, the lateral being the one most frequently ruptured. So that the parietal region is the one in which blood is most frequently effused between the dura mater and the skull. It has to be borne in mind that considerable effusions of blood may occur without giving rise to marked symptoms, if the effusion takes place slowly.

Traumatic effusion of blood frequently occurs *in the cavity of the arachnoid.* Its existence in this particular position cannot be diagnosed from that on the outside of the dura mater. But if the surgeon, led by the symptoms of localisation, has trephined on account of blood causing pressure on the brain, and finds none between the dura mater and the skull, he will be able to discern, by the dark blue appearance of this membrane, the presence of blood in the arachnoid. Blood effused into this region undergoes changes of a somewhat peculiar kind. The clot generally becomes attached to the parietal layer of the arachnoid, and later it becomes vascular, by penetration of the loops of capillaries. It ultimately may be converted into fibrous, and it is said even into cartilaginous, structures. Frequently these are cystic in form, and may be either attached to one of the layers of the arachnoid membrane, or remain free in its cavity.

Extravasations of blood *beneath the arachnoid* spread all over the brain-surface, and are not confined to the area in which they originate. They are generally associated with lacerations of brain-tissue. Unless very extensive, they do not readily lead to distinct manifestations of brain-symptoms.

Effusions of blood *into the brain* are common accompaniments of laceration and contusion of cerebral substance, and the symptoms are apoplectic in their character. Compression of the anterior part of the brain is much less serious to life than when it implicates the middle or posterior lobes. The symptoms of compression of the anterior lobes are very slow in appearing, and are frequently of such a slight character as not to be observable, unless on very close attention. Compression of any part of the motor area is generally easily recognised.

The prognosis of compression, due to extravasated blood, depends greatly on the seat of the pressure, and also as to whether there has been pouring out of blood into the brain-tissue, as, in the latter case, there is frequently irreparable destruction of the parts into which the blood has been poured. When effusion of blood takes place into the central parts of the brain, pons varolii, or medulla oblongata, or if there be great effusion into the ventricles, the condition is much more serious than when it is superficial, or exists between the skull and the dura mater.

Treatment of compression.—The cause of the compression ought, if possible, to be removed. The treatment of compression arising from depressed fracture and inflammatory action within the skull, is fully dealt with under SKULL, Fracture of the; ENCEPHALITIS; suffice it to say here, that the bone ought to be elevated in the former, while exit to inflammatory effusion ought to be afforded in the latter. Cerebral tumours, which have been localised and which are situated in any accessible region of the brain, especially in the cortex, should be removed. Regarding effusions of blood, they present the most readily removable of all the causes of compression, more especially as the majority of them, arising from traumatism, are found on the periphery of the intracranial structures; and also, as they are free from the complication of inflammatory products (at least soon after the occurrence), which so often accompany other lesions occasioning compression. In trephining for the relief of pressure caused by blood, a large disc of bone should be elevated. If the blood be situated immediately beneath the skull, it will present itself whenever the bone has been withdrawn. The surgeon should then examine the aperture carefully, passing the probe between the dura mater and the skull, and by this means removing adherent blood-clots.

If the blood be in the cavity of the arachnoid, it will be recognised by the dark blue colour shown through the superficial membranes. The dura mater should then be freely opened, and the blood withdrawn. In some instances blood will present itself as a dark body in the pia mater or in the periphery of the brain-substance. This should be taken away. After all the effused blood has been removed from the interior of the skull as far as practicable, the bone should be replaced, an exit for drainage being kept patent. The scalp should then be brought carefully together, and the wound dressed antiseptically. If these operations are done aseptically, there is no fear of the procedure itself increasing the danger of the case. The statistics of such operations in the writer's practice are very favourable.

The patient ought to be kept quietly at rest in bed, the head shaven, the bowels freely acted on, and the diet restricted to milk or beef-tea. *See* HEAD-INJURIES, Diagnosis of. WILLIAM MACEWEN.

BRAIN, Concussion of the.—Concussion is a form of shock. Shock may arise from either mental or physical impressions. Physical impressions may produce shock, either directly by acting on the brain through the skull, or indirectly by the depressing influences conveyed to the central nervous system by the nerves of the part of the body which has been injured. In either case, a functional paralysis results. Peripheral shock arises from sudden, extensive, and severe injuries to any part of the body, but it is most prone to follow injuries of the abdominal viscera, the genitals, the bones, and the joints. Central shock or concussion originates from violent blows or falls, which produce shaking of the whole brain. These may act directly on the head, or they may do so through the trunk, the person falling from a height on the feet or buttocks.

Concussion may therefore be defined as that form of shock which arises from direct commotion of the cerebral substance, resulting in functional paralysis. In some post-mortem examinations of cases of this description, no cerebral structural lesions of any kind have been discovered, even with the use of the microscope. It is true that in many such cases the spine has not been examined. In others, minute hæmorrhagic extravasations have been found in the pia mater or in the substance of the brain. When lacerations existed, it is probable that these would have indicated their presence during life, by distinctive symptoms, had time been afforded for their development, the concussion meantime having masked the other symptoms. The morbid physiology of this cerebral loss of function is obscure. Various theories have been advanced; the most popular is the assumption of a molecular disturbance of the protoplasm of the brain-tissue. Uncomplicated cases (of concussion) are comparatively seldom seen by hospital surgeons. The majority of cases of concussion are associated with some head lesion, which forms a complication, such as fracture of the skull, laceration, contusion, and compression of the brain. In many instances the concussion is at first paramount, but, as it begins to pass off, the indications of the other lesions manifest themselves. In other instances, compression, when localised, is apparent at an early period, along with a certain amount of concussion.

The *symptoms* of concussion are generally described as occurring in four stages—collapse, rallying, reaction, and gradual convalescence. The stage of collapse may be indicated by very varied symptoms. In slight cases there may only be vertigo and mental confusion, with faintness. In others, the patient is insensible, like a person in a deep faint—stunned. The skin is cold and pallid; the features blanched and contracted; the respirations superficial and shallow, and sometimes sighing; the pulse feeble or imperceptible; the reflex actions abolished; but there is no true paralysis. In this stage of insensibility, the pupils are always dilated. When they are otherwise, it indicates the existence of some complication. The period of rallying is generally ushered in by vomiting, and sometimes by an epileptiform attack. The reflex actions can now be excited, the pallor leaves the face, the pulse becomes stronger, the respirations more distinct, consciousness returns, and the whole condition of the patient begins to improve. This period of rallying may occur a few minutes after the injury, or the patient may remain in a collapsed condition for days prior to the rallying.

Reaction follows, with increased temperature, hot skin, flushed face, quick bounding pulse, and scanty urine. In severe cases the patient may die comatose, with symptoms of inflammation of the brain. In slight cases the period of reaction may be almost imperceptible, and the patient may pass gradually into convalescence. It is during the period of reaction that many lesions of the brain, previously masked, show themselves, such as localised compression, contusion, or laceration; and it is in these cases that the reactionary period is most likely to be marked by inflammatory symptoms. In uncomplicated cases of concussion the period of reaction is comparatively short, but when encephalitis arises it may last for weeks. The convalescent stage may be short or protracted, according to the condition established during the period of reaction. During convalescence many complain of languor, headache, and inability to work.

In uncomplicated cases of concussion, a fatal issue may occur during the period of collapse; but when reaction is fairly established comparatively few succumb, unless inflammation of the brain supervene. Though the majority of cases of simple concussion recover perfectly, in some there remains impairment of mental powers and of sensory functions, and these defects are at times permanent.

Treatment.—During the period of collapse, the patient ought to be enveloped in warm blankets, and have hot bottles or bags applied to the feet. A rectal injection of warm water, or diluted beef-tea, has often the desired effect of promoting reaction. Stimulants ought seldom to be employed, and when they are, they should be used with the greatest circumspection. The patient ought to be kept in bed in a quiet room, and his stay in bed ought not to be less than a fortnight, in the mildest cases. His diet ought to consist of little else than milk, until the convalescence has been fully developed. During the reactionary period, the head should be shaven, the room darkened, and the bowels acted on by mild purges. *See* HEAD-INJURIES, Diagnosis of. WILLIAM MACEWEN.

BRAIN, Hernia of the.—When a portion of brain-matter protrudes through an opening in the skull and its membranes, while its base is still continuous with the brain, a *hernia cerebri* has been established. In certain injuries brain-matter escapes, and is found on the outside of the skull, quite detached, and separated from the general mass of the brain. Such an escape of brain-matter ought not to be included under the title of hernia of the brain, though it is very commonly regarded as one.

Cerebral herniæ are divided into two classes—true and false. The former indicates a protrusion, containing the characteristic structures of cerebral substance, as may be verified under the microscope; the latter consisting of inflammatory new formation, often of masses of granulation-cells, the products of inflammatory action in the brain. Occasionally also these false herniæ consist of red cells, a little fibrin, and a few white corpuscles.

Hernia cerebri may be produced at the moment of injury. The writer has seen such cases. In one a portion of the frontal bone was driven into the brain; the hollow which was left by the depressed bone was filled to the level of the scalp by a pulsating mass of brain-matter, which had escaped at the moment of the accident. More frequently, however, the escape of brain-matter at the time of the accident takes place in the form of detached and separated pieces, which do not constitute herniæ. All cerebral herniæ and cerebral protrusions, occurring at the time of the injury, retain the white appearance of brain-matter, which they exhibit on being washed from the blood so apt to surround them. Herniæ of the brain usually occur some time after injury, and then are always mixed with inflammatory exudation in varying proportions; commonly the exudation forms the greater bulk. They rarely appear before the second or third day after the opening of the skull, and their appearance may be greatly delayed, weeks elapsing in some cases. While cerebral protrusions, occurring at the moment of injury, retain their natural appearance, those which take place some days afterwards present a greyish-red colour, and have a fungating aspect.

Herniæ generally occur on the upper and lateral aspects of the brain; they seldom protrude from the base. The frontal and parietal regions are their most common site. They are rarely or never found in the occipital region. There are cases on record where considerable quantities of brain-matter have been protruded through the base of the frontal and cribriform plate of the ethmoid, and have escaped through the nose. The writer has seen two cases where brain-matter was seen issuing from the ear, in fracture of the petrous bone. In one it was in small and detached pieces, in the other there was a considerable hernial protrusion of a fungating form presenting at the external orifice of the ear.

Formerly hernia cerebri was looked upon as the necessary sequence of wounds and injuries which penetrated the skull and brain-membranes, exposing the brain. Under altered conditions of treatment it rarely follows such wounds, and only arises when excessive inflammatory action of the brain-tissue has been set up. It is also erroneous to suppose that such inflammatory conditions can only arise as a consequence of wounds. It is true that the herniæ cannot exist without an aperture, but when there has been idiopathic inflammatory action of an excessive kind, the moment the skull is opened, the inflammatory products protrude and form the hernia cerebri.

Regarding prognosis, these herniæ may be divided into two kinds, primary and secondary. The primary herniæ are such as occur as the immediate results of an accident, when fresh healthy brain-matter has been protruded. In such instances the hernia, though it must be regarded as a serious lesion, does not often lead to a fatal issue. Quite a number of such cases have recovered. The good results obtainable depend greatly upon the treatment. The secondary herniæ are the sequents of inflammatory action in the brain, and are therefore to be regarded in a much more serious light. The majority of cases in which they occur prove fatal, not so much from the herniæ themselves as from the fact that they are mere indications of the extent of the inflammatory action in the interior of the brain. Still recovery does take place, in young people especially.

Treatment.—In all cases, scrupulous antiseptic precautions, with due regard to the prevention of irritation, ought to be adopted. Such measures are the most reliable prophylactics when the brain is exposed, and the best treatment when the inflammatory action is established. This is especially the case with herniæ, as they are very prone to undergo decomposition, and to give rise to a very fœtid odour. 1–1000 bichloride solution may be used as a wash, and the part may be covered with sublimated wood wool.

William Macewen.

BRASDOR'S OPERATION. — The term commonly used by French writers for the operation of applying a distal ligature. Wardrop was, however, the first to perform the operation. *See* Aneurism.

BREAST, Diseases of the.—Abnormalities of Secretion.—1. *Appearance of Milk unconnected with Pregnancy* is very rare. It has occurred as the result of allowing an infant to suck at the nipple.

2. *Agalactea or total Absence of Milk after Child-birth* is also rare, except in cases of premature delivery. Should there be delay in the appearance of the secretion, hot fomentations may be applied and the child put to the breast. By perseverance

in these means the secretion will usually be induced by the second day at latest. Deficient secretion is common in feeble and anæmic women. In such cases it is better to wean the child at once, as the imperfect supply is evidence that the mother is not fit to suckle.

3. *Galactorrhœa or Excessive Secretion of Milk.*—This may occur at an early period of lactation, and consist of a constant dribbling of milk from the swollen and distended breasts, or it may consist merely in a prolonged secretion in spite of efforts to arrest it by weaning the child. The former condition is an individual peculiarity, and its causes are doubtful; the latter is sometimes the result of prolonged suckling, or of uterine disease.

Treatment.—Galactorrhœa can usually be arrested by the external application of a paint composed of equal parts of glycerine and extract of belladonna, and by the internal administration of saline purgatives. In those cases which occur at an early period of lactation, iodide of potassium has been known to arrest the secretion.

HYPERTROPHY OF THE BREAST.—True hypertrophy is a rare disease. It consists simply in an enormous over-growth of the mammary tissue.

Causes.—It has been attributed to menstrual irregularity, excessive sexual excitement, blows, &c. It commences usually about puberty. Of 26 cases collected by Labarraque, only 5 were over twenty-six years of age. In some few cases the enlargement has been an exaggeration of the normal evolution of the breast in pregnancy.

Symptoms.—The chief symptom is the steady and often rapid enlargement, affecting both mammæ in most cases. There is little pain, the chief inconvenience arising from the size of the breasts. This may be enormous, the breasts sometimes resting on the thighs when the patient is in a sitting posture. Cases have been recorded in which the patient was unable to bear the weight of the mammæ when in the erect position, and their pressure has been such as to interfere with respiration when lying down. The enlarged glands are usually somewhat hard and knotty, but not tender. In those exceptional cases which occur during pregnancy, there may be galactorrhœa; in others there is no secretion of milk. The general health suffers when the enlargement is considerable, the patient becoming anæmic; amenorrhœa is commonly present. After reaching a certain size the growth ceases.

Diagnosis.—The only disease resembling hypertrophy is a large cysto-sarcoma. The affection of both breasts, the central position of the nipple, and the absence of cysts serve easily to distinguish hypertrophy.

Treatment.—Various preparations of iodine have been used internally and externally without effect; they may, however, be tried. The external application of belladonna might relieve pain. Pressure has been tried without success. If the encumbrance becomes great, the only efficient treatment is removal of the enlarged breasts.

NEURALGIA OF THE BREAST, OR MASTODYNIA.—The term neuralgia of the breast is properly applied to those cases in which pain is the only symptom, and in which no tumour or inflammatory induration is present. It is a rare affection.

Causes.—It is met with during the period of functional activity of the reproductive organs, and in all classes of society. It usually occurs in hysterical women, and is often associated with some uterine affection, with anæmia and habitual constipation. It has been attributed to blows or to the pressure of badly fitting stays.

Symptoms.—The pain is severe and paroxysmal, radiating from the breast to the neck, shoulder, or arm. It may be distinctly periodic in character, and is usually worse during menstruation. It is usually referred to the whole breast and not to any localised spot. There may be slight fulness of the affected gland.

Treatment.—Any uterine disturbance must be relieved, if possible. Constipation must be relieved by purgatives; anæmia by iron, animal food, and change of air to a bracing climate. Locally, the most useful treatment is the application of strips of belladonna plaster spread on leather in such a way as to support the breast and draw it slightly inwards. Opium in any form must be forbidden.

INFLAMMATORY AFFECTIONS OF THE BREAST.—*Acute Mastitis, Acute Parenchymatous Inflammation, Mammary Abscess, Milk Abscess.*—Acute inflammation of the breast may occur in both sexes and at all ages, but it is rare in adults except in connection with lactation. A form of inflammation occurs in new-born infants, and is termed mastitis neonatorum, and a similar condition is sometimes met with at puberty.

Causes.—The inflammation most commonly appears during the first month after delivery, and is usually supposed to be due to retention of milk from obstruction of a duct, but the evidence of this is not very good. In many cases it is preceded by a sore nipple, and possibly extension of the inflammation into the deeper structures may then be the true cause. Blows and exposure to cold during lactation are occasional causes. Mammary abscess is most common in women who nurse their own children, and in primiparæ. It is not a common consequence of enforced arrest of the secretion, as after the death of the child. The pus of an acute mammary abscess always contains micrococci, but how they get there, and what part they play in the causation of puerperal mastitis, are points not definitely determined.

Symptoms.—The first symptom is often some swelling and engorgement; there is pain, aggravated when the child is put to the breast. There is a feeling of weight, relieved by supporting the gland with a bandage or handkerchief. On examining the breast an ill-defined hardness is felt, most commonly towards the lower and outer side. Sometimes several such patches may be present. There is acute tenderness on pressure, and some œdema of the subcutaneous tissue. The thermometer shows some elevation of temperature. As the inflammation progresses, the thermometer rises to 102° F. or 103° F. or even higher, and there may be a rigor. The œdema increases over the indurated part, the skin reddens and fluctuation becomes distinct. If left unrelieved, the abscess may reach such a size as to contain many ounces of pus before it bursts. Both breasts are rarely affected. Under proper treatment the inflammation may subside without reaching the stage of suppuration, in fact this probably occurs in about half the cases.

Pathological Anatomy.—The observations on these cases are very few, and have been chiefly made in women dying of puerperal septicæmia or pyæmia. The ordinary signs of inflammation are found, the chief exudation being at first around the acini, but this does not prove that the source of iritation arises from within them, for similar appearances can be produced in animals by passing a seton through the gland. It is due merely to the vessels and lymphatics being most abundant in that situation.

Treatment.—This must at first be directed to the prevention of suppuration. The child must be removed from the affected breast, and the milk gently drawn with a breast pump. If the patient be weak the infant must be weaned. The arm must be fixed to the side to secure rest. The breast must be supported by a handkerchief or bandage passing over the opposite shoulder, and the patient should be kept as much as possible in the recumbent position. The part should then be painted with extract of belladonna and glycerine (equal parts) and hot fomentations constantly applied. Leeches are of little or no use and cold applications only do harm. Linseed-meal poultices are too heavy. If it be intended to arrest the secretion of milk, the bowels must be kept gently relaxed by means of saline purgatives.

If, in spite of this treatment, pus forms, when should it be let out? Some surgeons recommend opening as late as possible, or even leaving the abscess to burst. There seems no reason why the patient's pain and fever should thus be needlessly prolonged. To cut deeply into so vascular an organ as the actively secreting mamma in search of doubtful pus would certainly be wrong; but as soon as its presence is proved by the aspirator, or by fluctuation, it should be let out. The abscess should be opened with efficient antiseptic precautions (*see* ANTISEPTIC SURGERY), and no cases better repay the little extra trouble involved in so doing. The incision must be so placed as to radiate from the nipple in order to avoid damage to the ducts. It need not be larger than is necessary to admit a drainage-tube of $\frac{3}{8}$ inch in diameter, or even smaller if the abscess be not of great size. Great care must be taken, however, to ensure efficient drainage.

Consequences of Puerperal Mastitis.—Inflammation, which has stopped short of suppuration, leaves more or less induration of the inflamed area, lasting for many months or even permanently. This condition may very closely resemble scirrhous cancer. *See* BREAST, Tumours of the, Diagnosis of. When an abscess has existed the induration is usually more marked, but the nature of the case is made more evident by the scar. These indurations sometimes become the starting-point of cancer. In the cases of carcinoma of the breast collected by Gross the disease arose in this way in 8·21 per cent.

Fistulous tracks or sinuses occasionally remain after a mammary abscess has been opened. These discharge a thin fluid not unlike human milk, but a true lacteal fistula is a very rare occurrence. Most commonly the sinus leads to a cavity surrounded by indurated tissue and imperfectly drained. A true lacteal fistula will not heal till the secretion of milk is arrested. A sinus leading to a cavity is best treated by enlarging the orifice. If the discharges are decomposing, the cavity should be scraped with a sharp spoon, and then cleaned with a small piece of sponge held in a pair of forceps and soaked in a solution of chloride of zinc (40 gr. to f ℥j). This treatment is almost invariably followed by rapid healing.

Mastitis Neonatorum.—In new-born children of both sexes the rudimentary mamma becomes slightly swollen about the third or fourth day of life, and if at this time it be gently squeezed a small quantity of alkaline fluid containing colostrum corpuscles can be squeezed from it. The swelling and secretion reach their maximum on the tenth day and then gradually subside.

Acute submammary abscess.—A submammary abscess is a collection of pus in the areolar tissue between the gland and the pectoralis major. It is met with, almost exclusively, in puerperal women, and is, most probably, due to suppuration commencing in a deep lobule of the gland.

Symptoms.—The earliest symptoms are deep-seated pain, increased when the child is at the breast, tenderness, and febrile disturbance. As soon as the inflammation extends to the submammary areolar tissue, the symptoms are intensified. The breast becomes tense and full, and is pushed forwards bodily. There is severe pain, greatly increased by moving the arm. The febrile disturbance in this stage is very great. At first no fluctuation can be detected, but, after a time, redness and œdema, followed by distinct evidence of fluid, appear at some point of the circumference of the gland, most commonly the outer and lower border. Sometimes pus may point in more than one place. If left to itself the abscess bursts, sometimes at several points in the circumference of the gland, leaving sinuses which are very slow to heal.

Diagnosis.—The diagnosis is made by observing that the pain is increased by movements of the arm, or by moving the gland over the pectoralis major. The general prominence of the swollen breast is another important sign.

Treatment.—In the early stages the same treatment must be adopted as in ordinary puerperal mastitis, in the hope of preventing suppuration. The arm must, at the same time, be firmly fixed by bandages to the side. As soon as it is evident that pus is present, a free opening must be made in the place at which it is pointing. The incision should be parallel to the border of the gland and not directed towards the nipple, otherwise the gland is needlessly wounded. A large drainage-tube should be inserted, and some efficient antiseptic dressing applied. The troublesome sinuses which not uncommonly form are due, in most cases, to insufficient drainage and the presence of a cavity beneath the mamma containing decomposing pus. Under these circumstances, the orifices of the sinuses must be enlarged, so as to admit the finger. The cavity and sinuses are then to be scraped with a sharp spoon and cleaned by means of a sponge soaked in a solution of chloride of zinc (40 gr. to f ℥j.). Drainage-tubes may then be inserted and gradually withdrawn as the cavity closes, some antiseptic dressing being applied. A counter-opening must be made at the most dependent part if necessary.

Chronic Inflammatory Affections of the Breast.—*Chronic lobular interstitial mastitis* of one, or of several lobules, of the breast, is not uncommon in women past middle life, and is occasionally met with at an earlier period. The *causes* of this affection are very uncertain. It seems, in some cases, to be associated with uterine disease, but this is by no means constant. It is most common at the period of the cessation of menstruation, but is also occasionally met with in young women. Women who have borne children are more liable to it.

Symptoms.—The patient's attention is usually attracted to the breast by some pain and tenderness. Sometimes this is very severe, neuralgic in character, and aggravated at the menstrual period. On examining the breast an indurated nodule will be felt, varying in size from a filbert to a walnut, but seldom reaching the latter size. The patient often states that there is some increase of size at the menstrual period. The nodule does not slip about in the gland, but is evidently part of the gland itself. The outline of the indurated lobule is ill-defined and it gives a sensation rather of leathery toughness than stony hardness. Small projections of great hardness are sometimes to be felt in it. These are small and very tense cysts. When the nodule is of considerable size and very superficial, the skin may dimple slightly over it when pinched up between the finger and thumb. After the affected lobule has reached a certain size the disease tends to become stationary, and often the pain subsides and the patient suffers no further trouble. Several such lobules are occasionally met with in one breast, and both glands are not infrequently affected.

Pathology.—The indurated lobule is dense and leathery in consistence, opaque white in colour, and can often be seen by the naked eye to be composed chiefly of bundles of fibrous tissue. Small cysts, seldom as large as a pea, tensely distended with fluid, either clear, or turbid and brownish in colour, are often scattered through it. The outlines of the diseased lobule are not clearly defined. It differs from scirrhous cancer in its leathery consistence and its flatness on section, and in not yielding a milky juice on scraping. Microscopic examination shows that it is a genuine interstitial inflammation. In the advancing margin the interacinous connective tissue is infiltrated with small round cells. In the more advanced stages these are found to have developed into dense fibrous tissue, the process being accompanied by contraction, as in the analogous conditions of cirrhosis of the liver or kidney. By this contraction the ducts are pressed on, and, as at the same time there is some slight excess of secretion in the acini, small retention cysts are formed.

Prognosis.—The disease tends to become stationary after reaching a certain point. It is possible that occasionally the indurated lobule may be the starting-point of a cancer, but this is certainly rare.

Diagnosis.—Chronic lobular interstitial mastitis may be mistaken for a chronic abscess, an adeno-fibroma, a cyst or scirrhous cancer. From an adeno-fibroma it is distinguished by its want of mobility in the gland and its ill-defined outline; from a cyst by its want of elasticity and its irregular outline; from a chronic abscess by its not arising in connection with pregnancy or lactation, and by the absence of œdema over it. In cases of doubt a grooved needle may be inserted, which will at once show the true nature of a chronic abscess or cyst. From scirrhous cancer the diagnosis is often so difficult that it can only be made by means of an incision into the nodule. *See* BREAST, Tumours of the, Diagnosis of.

Treatment.—The treatment of this disease is not very satisfactory. Blistering, tincture of iodine, and other counter-irritants have usually little effect. The inunction of mercurial ointment is often recommended, but is of doubtful utility. The pain is best relieved by the application of a belladonna plaster. Should there be any concomitant uterine disorder, it must be attended to. If the patient is anæmic, the pain is usually more severe, and relief is then obtained by the administration of iron. Sir James Paget speaks of the following mixture as, in some cases, promoting absorption of the induration: ℞ Liq. potassæ fʒj., Pot. iodidi gr. ij. To be taken three times a day, after meals, in not less than f℥iv. of any simple liquid. If everything else fails, and the patient's mind is much disturbed by the fear of cancer, a single lobule may be excised.

Chronic Abscess of the Breast. Encysted Abscess.—This somewhat rare affection derives its interest from the close resemblance that it bears to scirrhous cancer.

Causes.—Chronic encysted abscess almost invariably arises in connection with pregnancy, and very frequently with miscarriage or abortion. Gross states that he has seen it in scrofulous subjects independent of impregnation.

Symptoms.—The symptoms closely resemble those of chronic lobular interstitial mastitis. There is a hard lump in the breast, seldom reaching the size of a walnut; it is tender, but not markedly so, and may be the seat of some pain. Its outline is ill-defined; it evidently implicates the mammary tissue and cannot be separated from it. There is some œdema of the tissues covering it, and if the skin be pinched up there is usually slight dimpling. In this state it may remain for many months without marked change. If it reaches any considerable size there may be a sense of elasticity in its central part. Finally it may become definitely adherent to the skin. There may be slight enlargement of the nearest axillary gland.

Pathology.—If a chronic abscess be examined by a section carried through it, it is found to be situated in a lobule of the mamma. In the centre is a small cavity lined with granulation-tissue containing thick pus. The tissue surrounding this cavity is composed of dense fibroid tissue, in the midst of which remains of the glandular structure may be recognised.

Diagnosis.—From an adeno-fibroma it is distinguished by its ill-defined outline and its implication of the glandular tissue. The presence of œdema, the dimpling of the skin, and its ill-defined outline will usually serve to distinguish it from a cyst. The distinction from chronic interstitial inflammation without suppuration is very difficult, but the œdema may serve to show its real nature. From scirrhous cancer it may be almost indistinguishable, except by puncture or incision. *See* BREAST, Tumours of the, Diagnosis of. Many breasts have been removed needlessly for want of taking the precaution of cutting into a doubtful induration before proceeding to the operation.

Treatment.—The only treatment is to open the cavity. Healing will be promoted by scraping it with a sharp spoon.

TUBERCLE OF THE BREAST.—The mamma is very rarely the seat of tubercle. Grey granulations have never been observed in it. Billroth records a case in which numerous caseous nodules were found in the breast of a young woman who died of pulmonary tuberculosis. Duret and Dubar have described some cases in which chronic abscesses with curdy contents slowly formed in the breast, but the evidence that they were tubercular is not perfect.

Syphilitic Diseases of the Breast.—Primary sores and mucous tubercles on the nipple are occasionally met with. Chronic diffuse induration of the gland and the formation of gummata in it have also been described, but there can be no doubt that these conditions are exceedingly rare. Ambrosoli describes cases of diffuse induration which disappeared under iodide of potassium. Gummata have been described by various authors, as forming painless swellings commencing in the mammary tissue and gradually increasing till they reach the surface. Softening then takes place, and finally the skin gives way, exposing the characteristic slough, resembling wet washleather in appearance. This separates slowly, leaving a deep excavated ulcer. Further observations, however, are required before syphilitic diseases of the breast can be described with any certainty.

Tumours of the Breast.—*Cysts.*—Excluding cysts in solid tumours, three forms are met with in the breast:—1. Retention Cysts; 2. Serous Cysts; and, 3. Hydatid Cysts.

1. *Retention Cysts.*—These are formed by dilatation of the acini or ducts of the gland. The conditions essential to their formation are, obstruction to a duct and some excess of secretion from the part where the cyst is formed. Galactocele, which properly belongs to the class of retention cysts, has been already described with errors of secretion. Excluding galactocele the following varieties of retention cyst are met with:—

(*a*) *Involution Cysts.*—These are formed in the indurated and atrophied breasts of old women. They are usually numerous, and scattered throughout different parts of the gland. They seldom reach any considerable size, and are of little importance.

(*b*) Cysts, as already stated, are common in the indurated part *in chronic lobular interstitial mastitis.* They seldom reach any size.

(*c*) Retention cysts arising independently of these conditions are usually termed *glandular* or *duct cysts.* They may be single or multiple. They may be seated deeply in the gland or superficially near the nipple. They are composed of a fibrous vascular wall lined with epithelium, which is either cubical or inclining towards columnar in form. Their contents are thick, sometimes resembling mucus in consistence, turbid, brownish, or yellowish in colour, and frequently stained with recent blood. Intracystic growths are not uncommon. They are composed of delicate vascular papillæ, covered with epithelium springing up from the walls of the cyst and sometimes almost filling its cavity. It is possible that in some cases this condition may end in the peculiar form of cancer termed villous or duct cancer. See *Cancer of the Breast,* below. The obstruction of the duct leading to the cavity is in many cases not complete, and the contents can be made to flow from the nipple by firm pressure on the cyst. The *causes* of these cysts are uncertain; they are most common in women under forty, and are often attributed to a blow.

2. *Serous Cysts.*—These are supposed to be formed, as in other parts of the body, by dilatation of the lymph-spaces of the connective tissue. The walls are composed of fibrous tissue, lined internally by an imperfect layer of flattened endothelial cells. Their contents are usually clear serous fluid rich in albumen, but they may be altered by an admixture of blood. Serous cysts are usually single and often multilocular, but may be multiple. They may reach a considerable size, containing some ounces of fluid. Nothing is definitely known as to their cause.

3. *Hydatid Cysts of the Breast* are very rare in this country. When they occur they present no special peculiarities. *See* Hydatids.

Symptoms of Cysts of the Breast.—A cyst of the breast forms a slowly-growing, rounded, tense, or elastic tumour, sometimes smooth, often lobulated, on the surface. Its outline is in some cases tolerably clearly defined; in others it is obscured by indurated glandular tissue around it. It is attached to the gland, and not movable independently of the mammary tissue. It is free from pain and tenderness.

Treatment.—Glandular or serous cysts, if single, may be cured by making an opening large enough to admit a small sponge moistened with chloride of zinc (gr. 40 to f℥j). With this the inside may be thoroughly scrubbed. A drainage-tube is then to be inserted, and an antiseptic dressing of some sort applied. Under this treatment the cavity will usually close. If the case be one of a glandular cyst with intracystic growth, or if there be much induration of the surrounding mammary tissue, the whole of the affected lobe of the breast should be removed.

Adenoma, Adeno-fibroma, Adeno-sarcoma, and Cysto-sarcoma.—These tumours are so closely allied pathologically that they may be considered merely modifications of a single form of morbid growth. They are all composed of a vascular connective tissue, modified according to the form assumed by the growth, surrounding spaces lined with cubical epithelium, and containing a variable quantity of clear fluid. They are enclosed in a capsule of fibrous tissue, and do not infiltrate the surrounding parts. By most German pathologists the connective tissue is regarded as the essential feature of the growth, and the spaces as more or less accidental remains of ducts or acini, and the term adenoma has consequently not been applied to them by those who hold this view. English pathologists and clinical surgeons have, however, regarded the epithelium-lined spaces as of equal importance with the surrounding connective tissue, and have consequently classed these growths with adenomata.

The following are the modifications met with:—(*a*) A dense, well-developed, fibrous stroma surrounding large spaces, containing little fluid, and consequently flattened or slit-like. This forms the common *adenoma*, or *chronic mammary tumour.*

(*b*) A less perfectly developed fibrous stroma, composed of fibrous tissue abundantly infiltrated with small round cells, or a small amount of fibrous tissue mixed with oat-shaped cells, or of spindle-shaped cells with scarcely any fibrous tissue between them, surrounding spaces containing more fluid, and consequently rounded or oval. This forms the *adeno-sarcoma.*

(*c*) Sometimes the half-developed connective tissue contains numerous stellate cells, and some mucous intercellular substance. This forms the *myxo-sarcoma* or *adeno-myxo-sarcoma.*

(*d*) A tolerably well-developed fibrous stroma, surrounding large spaces filled with fluid, and forming intracystic growths projecting into the cavities, sometimes nearly filling them. This is the *cysto-sarcoma* or *proliferous cyst of the mamma.*

For clinical purposes these tumours may be divided into three groups:—The adeno-fibroma or simple adenoma, the adeno-sarcoma, and the cysto-sarcoma.

Adeno-fibroma. — *Causes.* — These tumours are sometimes attributed to a blow, but we have no real knowledge of their mode of origin. They occur most frequently in young women under thirty.

Symptoms.—The tumour is small when first observed, and situated near the circumference of the gland, usually at the upper or outer part. It is hard, clearly defined, freely movable in the mamma, and has no adhesions to the skin, the deep parts, or the gland. The surface is smooth or smoothly lobulated. It may be painless and free from tenderness, but in hysterical women it is often the seat of intense pain, so much so that the term 'painful mammary tumour' has sometimes been applied to it. Its growth is slow and it may often remain stationary for years; but in other cases it steadily increases, and may attain the size of a small orange without materially altering in its other features.

Pathological Anatomy.—The tumour on section is of a bluish or greyish white colour, becoming pink on exposure to the air; the flattened spaces give it a peculiar foliated structure somewhat resembling the section of a cabbage, which becomes more apparent after the tumour has been immersed in spirit for a short time. It yields no juice on scraping.

Adeno-sarcoma. — An adeno-sarcoma may arise as such, and grow rapidly from the first, or may develop by the rapid increase of a tumour which has presented for many years the appearances of a simple adeno-fibroma. It is met with most commonly in women between thirty and forty. The tumour is lobulated, elastic, painless, and free from tenderness. Its outline is clearly defined, and it is separable from the mammary tissue till it attains a considerable size. Finally, from the tension it causes, the surrounding parts become irritated and adherent to it. The mammary gland may sometimes seem to be involved in the growth, when it is really atrophied from pressure. If the tumour be allowed to grow unchecked, the skin gives way, and a fungating vascular growth protrudes, death taking place from loss of blood and exhaustion. The lymphatic glands are not affected, and recurrence in internal organs is very rare.

Pathological Anatomy.—The tumour on section is usually seen to be perfectly free from adhesion to surrounding parts. It yields in many cases an abundant slimy juice, but on scraping no milk fluid is obtained. Rounded cysts of considerable size are frequently scattered through it.

Cysto-sarcoma, Proliferous Cysts. — These tumours closely resemble in their history and mode of growth the adeno-sarcoma just described, but as a rule they develop more slowly. They occur more commonly after thirty than before. They form elastic lobulated tumours, with fluctuating points scattered through them. They may reach an enormous size without forming any adhesions to the deeper parts. The skin covering them is usually traversed by large veins, but does not become adherent or ulcerate till a late period. If left to grow, ulceration at last takes place and a fungating growth protrudes, and death occurs from exhaustion. The lymphatic glands are never affected and internal recurrences do not occur.

Pathological Anatomy. — A section through the tumour shows it to contain innumerable cysts, varying in size from a pin's head to an orange. The fluid contents are usually thick and viscid. In many of the cysts are intracystic growths. These are usually pedunculated, springing from one side of the cavity and projecting into it like the head of a cauliflower. The solid substance is white or pink in colour, and usually of firm consistence.

Prognosis.—All these tumours are simple in character, and do not return if removed completely.

Treatment.—Small adeno-fibromata are said to have been absorbed under the application of iodine, mercurial ointment, or pressure. It is, however, probable that in every case in which this has been supposed to occur, the tumour was in reality merely an indurated lobule of the gland, resulting from chronic inflammation. The only efficient treatment is removal of the tumour. Even when an adeno-fibroma is stationary, it is wiser to excise it, as it is impossible to say when it may not assume rapid growth and endanger life. In the larger tumours the absence of adhesion to the skin and deep parts renders the removal easy, even when the growth may have attained the size of a cocoa-nut. The breast should not be taken away if it can be avoided, but when the tumour is of great size the gland is so spread out over it and atrophied that it is often impossible to save it.

The removal of the smaller growths is done by a single incision radiating from the nipple. As soon as the capsule is opened, the shining surface of the growth comes into view and the tumour may then often be shelled out by the fingers with the greatest ease. A small pedicle is sometimes found containing the vessels. The operation should be performed with antiseptic precautions, and drainage must be very carefully attended to, lest pus form and burrow deeply beneath the mamma. The safe closure of the cavity is much facilitated by combining elastic pressure with drainage, and for this purpose an absorbent wool dressing will be found of great use.

When the breast cannot be saved, the operation is similar to that for removal of the mamma for cancer, but there is no necessity to remove any skin save that which is actually adherent to the growth.

Fibroma of the Breast.—Pure fibroma of the breast is very rare. It can only be distinguished from the adeno-fibroma by microscopic examination after removal.

Lipoma.—Fatty tumours occur in the immediate neighbourhood of the mamma, and may simulate disease of the breast. Their real seat of origin is the subcutaneous tissue over the gland.

Sarcomata of the Breast. — Various forms of sarcoma are met with in the breast, or its immediate neighbourhood. They differ from the adeno-sarcomata just described in the total absence of any glandular element. Should cysts be present they are due to hæmorrhage or softening of the growth, and not to the presence of epithelium-lined spaces. The most common form of sarcoma met with is the spindle-celled variety, but myxo-sarcoma is not uncommon, and round-celled and giant-celled sarcomata have been occasionally observed.

Causes.—Nothing is known as to the causes of these growths. They are most common in women above thirty.

Symptoms.—In many cases it is quite impossible to distinguish between a soft adeno-sarcoma and a sarcoma, before the growth is removed and submitted to microscopic examination. In other cases the less defined outline, the rapid growth, the uniform semi-elastic or almost fluctuating feel, and the absence of lobulation may lead to a strong suspicion that the tumour is a sarcoma. The lymphatic glands are not affected. If not arrested by treatment these tumours sooner or later implicate the skin, ulceration takes place, a fungating growth protrudes, and death follows from exhaustion.

Pathological Anatomy.—The tumour is soft and pink, and yields a bloody or viscid fluid with shreds of the tumour on scraping. The outline of the tumour will usually be found less clearly defined than that of an adeno-sarcoma, though there is often a fibrous capsule round the growth, yet the tumour cannot be shelled out of it or dissected from the surrounding parts without considerable trouble.

Prognosis.—The prognosis of a pure sarcoma of the breast is always much more grave than that of an adeno-sarcoma. It is in this region that the curious tendency, shown especially by spindle-celled sarcoma, to return locally after removal without affecting internal organs or lymphatic glands, has been most frequently met with. In some fortunate cases the repeated removal of the local recurrences has at last cured the patient, but more commonly the disease soon gets beyond the reach of surgical interference. Recurrence in internal organs is also met with in some cases.

Treatment.—The complete removal of the growth is the only treatment. From the impossibility of accurately distinguishing a pure sarcoma from an adeno-sarcoma, an attempt is usually made in these cases to dissect out the growth. If it be found, on removal, to present the appearances of a pure sarcoma, the capsule surrounding it should be freely dissected away, and it would doubtless be safer, if the patient's consent had been previously obtained, to remove the whole gland. Should local recurrences take place, they may be removed as long as there is any possibility of doing so; and even after no further complete operation is possible, relief may be given by scraping away the fungating mass and freely cauterising its base.

CANCER OF THE BREAST.—All forms of carcinoma are met with in the female breast. The typical variety, forming at least 99 per cent. of all cases, is glandular cancer, usually occurring as scirrhus, rarely as encephaloid, and still more rarely as colloid. Columnar epithelioma has been observed, springing from the ducts, and squamous epithelioma is occasionally met with at the nipple, belonging rather to the skin than to the mammary gland.

Hereditary tendency.—According to Gross an hereditary tendency to the disease existed in one case in 9·72. But Sir James Paget, from the experience of private practice, puts the proportion as high as 1 in 4.

Age.—Cancer of the breast is never met with before puberty. In 642 cases collected and analysed by Gross, 18 appeared between twenty and thirty years of age, 128 between thirty and forty, 245 between forty and fifty, 165 between fifty and sixty, 78 between sixty and seventy, and 8 between seventy and eighty. Thus by far the greater number occur at that period of life at which the reproductive function is ceasing, only 22·74 per cent. arising during the period of greatest activity. The diminution after fifty is not merely due to the fact that in each successive decade fewer women are alive. The proportion of women living between forty and fifty to those between sixty and seventy is about 25 to 16, whereas the proportion of cases of cancer arising in these decades may be roughly given as 25 to 8. The youngest authentic case of cancer of the breast is that recorded by Henry, of Breslau, occurring in a woman aged twenty-one.

The *cessation of menstruation* seems to exert no marked influence. About 61 per cent. of all cases occur before the menopause. In only 6·41 per cent. of cases was the menstrual function irregular.

Social Condition.—It is difficult to say whether the disease is relatively more frequent in married or single women. According to Gross in 88·82 per cent. the patients were, or had been, married, and in 83·91 per cent. they had borne children, and 73·74 per cent. of these had suckled their infants. The disease arose during pregnancy or lactation in about 5 per cent.

The *previous general health* apparently exerts no influence. The great majority of patients enjoy excellent health at the time of the appearance of the disease, and in most cases for some months afterwards.

Local causes.—It is a popular notion that cancer very commonly arises as the result of a blow. According to Gross, 11·7 per cent. of the patients attributed the disease to an injury; but this history must always be regarded with some suspicion, as few women are willing to acknowledge that the tumour arose independently of an external cause. In eight per cent. of Gross's cases the disease attacked a gland which had previously been the seat of puerperal mastitis. Sir James Paget is also of the opinion that chronic indurations not infrequently become the starting-point of cancer after a longer or shorter period. Psoriasis, or eczema of the nipple (*see* NIPPLE, Diseases of the), is a precursor of cancer in not more than one per cent. of the cases.

Varieties of Cancer of the Breast.—For the purposes of clinical description, cancer of the breast may be thus divided:—A. Scirrhous or hard cancer. *a.* Nodular or circumscribed scirrhus; *b.* infiltrating or diffused scirrhus; *c*, atrophying or atrophic scirrhus; *d*, cancer '*en cuirasse.*' B. Encephaloid, or soft cancer. C. Colloid cancer. D. Cystic cancer. E. Duct or villous cancer. Of these forms, scirrhous, encephaloid, and colloid cancer are varieties of glandular carcinoma; that is to say, they are composed of cells of the type of glan dular or spheroidal epithelium, filling the spaces of an alveolar fibrous stroma. In scirrhus the stroma is abundant, and consequently the tumour is dense and hard; in encephaloid the proportion of cells to stroma is such that the mass is comparatively soft; while in colloid the structure is modified by the colloid degeneration of the cells. Intermediate forms between scirrhus and encephaloid are not uncommonly met with, and, in cases of colloid cancer, parts of the tumour usually have escaped degeneration and present the appearance of ordinary cancer. Cystic cancer is very rare; it arises apparently from the softening and disintegration of the central parts of a soft cancer. Villous or duct cancer arises from the galactopherous ducts, and is characterised by the presence of columnar epithelium. It differs so much from the other forms as to require a separate description. It is difficult to state with accuracy the relative frequency of the various forms. Colloid, cystic, and villous cancer together would probably not form 1 per cent. of all cases. Of the remainder, about 85 per cent. would be ordinary scirrhus; 5 per cent. encephaloid; and the remainder atrophying scirrhus, cancer *en cuirasse*, &c.

SCIRRHUS.—*Symptoms.*—The *nodular* or *circumscribed* variety forms the type of cancer of the breast. The course of an ordinary cancer of the breast, unrelieved by treatment, may be divided into three stages. First, when the disease is limited to the gland; secondly, the stage of implication of the skin and the axillary lymphatic glands; and thirdly, the stage of ulceration and general infection.

First stage.—During the first stage the symptoms are entirely local. The patient may possibly lose flesh towards the end, but there is no constitutional condition characteristic of cancer. The chief symptom is the appearance of a hard lump in the breast, which slowly but steadily increases in size. In the majority of cases the tumour is discovered accidentally, as while washing, or the attention may be directed to it by a blow. Pain is not a marked symptom during the early periods of the disease, and may be entirely wanting till the second stage. Inspection of the breast shows nothing till towards the end of the first stage. Slight enlargement may then be perceptible; but as, in cancer, the new growth replaces the original structures, this is not so marked as in simple tumours of the same size. Retraction of the nipple is a common symptom towards the end of the first stage. The period at which it occurs depends considerably upon the situation of the tumour. If the cancer is in an outlying lobule, it occurs late or may be absent. If the disease is immediately under the nipple, retraction takes place early. By manipulation a hard nodule is recognised in the gland, most commonly situated either in the upper and outer segment or near the nipple. The nodule is single and tolerably clearly defined in outline, but a careful examination shows that it forms part of the gland itself. By the time the surgeon is called to see the case the tumour is seldom smaller than a filbert. It cannot be slipped about independently of the gland, and, if it be pushed away by the fingers of one hand while the nipple and areola are steadied by those of the other, the distinct connection of the tumour with the nipple by means of the ducts can be clearly recognised. The surface of the tumour is usually coarsely nodulated or irregular. Quite early in the disease, if the finger and thumb be placed about two inches apart so as to include the tumour between them, and the skin be then pinched up, a tendency to dimpling will be noticed over the nodule. In very exceptional cases there is a thin serous discharge from the nipple.

A combination of the above symptoms in a patient above thirty years of age justifies a further examination of the growth by incision. The duration of the first stage of cancer of the breast, according to Gross, averages 14·1 months.

Second stage.—As the tumour increases in size it gradually invades more and more of the gland, but, as it replaces the mammary tissue and contracts in its central parts while growing at its circumference, the actual increase in the bulk of the mamma is rarely very great. As the cancer approaches the surface, the skin becomes increasingly fixed over it, and finally infiltrated by it. When this has taken place the affected skin becomes smooth and leathery in consistence. It usually assumes a dusky red or brownish colour. If examined with a lens, small vessels are usually seen ramifying in it. The area of skin implicated varies in different cases, but it seldom reaches more than an inch in diameter before ulceration sets in. The tumour, although increased in size, retains its characteristic hardness, the central parts being the most dense. The retraction of the nipple becomes more marked. Pain is now almost a constant symptom, scarcely 10 per cent. escaping. It is acute, lancinating or burning, often severe at night, disturbing rest, and thus causing impairment of the general health. Sometimes it radiates for some distance from the breast, often to the shoulder. It is usually increased by handling the diseased breast, but there is rarely acute tenderness.

Enlargement of the axillary glands commences to be perceptible on an average about the fifteenth month. The frequency with which recurrence in the glands takes place after excision of the breast in the first stage of the disease is, however, clear proof that the actual infection takes place at a much earlier period, and that the absence of enlargement perceptible to the finger is no proof that the glands are sound. The glands first affected are usually those at the lower and anterior part of the axilla. In feeling for them the arm must not be raised, as, by so doing, the axillary fascia is put on the stretch, and thorough examination of the armpit becomes impossible. The general health suffers but little during this stage of the disease. Loss of flesh is almost a constant symptom, but in other respects there is little change.

Third stage.—The average period at which ulceration sets in is 20·2 months. It may commence in two ways. In the great majority of cases a small fissure forms in the affected skin, from which a sanious discharge escapes. This dries and forms a scab. After a time the scab falls off, and leaves an ulcer exposed. The edges of the ulcer are hard and raised, the surface is pinkish in colour, sometimes irregular, but more often smooth, and without granulations. In other cases it may be covered with a yellowish slough. The ulcer may remain superficial, or may extend into the tumour, forming a deep, foul cavity. The discharge is peculiarly offensive, the smell being that always met with whenever epithelial structures are decomposing. The pain is usually constant and severe.

In exceptional cases the ulceration is preceded by softening of a portion of the growth beneath the affected skin; this subsequently gives way, and a deep cavity is formed from the beginning. Hæmorrhage from the ulcerated surface is not uncommon, and is occasionally the immediate cause of death. By the time ulceration sets in, or soon after, the tumour frequently becomes adherent to, or implicates, the pectoralis major. This is recognised by its becoming fixed when the muscle is thrown into forced contraction. The glandular enlargement, which commenced during the second stage, extends during the third. The enlarged glands are more clearly felt, and often cause fulness beneath the clavicle. The supraclavicular glands, and even those behind the sterno-mastoid, may become affected. The pressure of the glands on the axillary vein at this time often causes great swelling of the arm, and severe neuralgic pain shooting down the limb may arise from pressure on the cords of the brachial plexus.

Should the patient not perish from the effects of the local disease and that of the axillary glands, infection of distant organs now takes place. This occurs in about half of those who are allowed to die unrelieved by operation. The organ most commonly affected is the liver. The enlargement of the liver may be ascertained by percussion, and the secondary tumours felt on the surface, below the costal margin. Jaundice, more or less marked, is a common symptom, but there is seldom much pain. The lungs are affected with half the frequency of the liver. The pleura, on the side corresponding to the diseased breast, is implicated more frequently than the lung, effusion often taking place, which is occasionally the immediate cause of death. Next in order to these organs, but far behind them, come the bones. Spontaneous fracture of long bones, or disease of the vertebræ, with the rapid occurrence of angular curvature, are the most common manifestations of secondary growths in the bones. Secondary tumours may occur in any other part of the body, but are rare except in the situations just mentioned.

During the whole of the third stage the general health suffers severely. The patient emaciates, and loses strength and appetite, the complexion becomes sallow, and the appearance—commonly described as that of the cancerous cachexia—becomes marked.

Death takes place on an average 27·1 months from the first appearance of the disease. The immediate causes of death may be exhaustion from pain and discharge, chronic septicæmia from absorption of the decomposing discharge, hæmorrhage, or secondary visceral disease.

The foregoing may be taken as a summary of the typical symptoms of cancer of the breast, as observed in an ordinary circumscribed scirrhus. In describing the course of the other varieties of the disease, it will only be necessary to indicate the points in which they deviate from the type.

(*a*) *Infiltrating or Diffused Scirrhus.*—This is far less common than the nodular form. It may commence as several small nodules, which coalesce as the disease advances, thus forming a large, hard, ill-defined tumour occupying the whole mamma. This diffused form of the disease grows more rapidly than the circumscribed, and causes considerable enlargement of the breast. The nipple is deeply depressed, as much by the projection of the growth round it as by retraction. The whole mass is hard, scarcely elastic, and lobulated on the surface. The skin may be extensively adherent from an early period. The pain is variable, rarely severe. Glandular affection occurs early. When ulceration takes place it extends deeply into the mass, forming a foul cavity of great size.

(*b*) *Atrophic*, *Atrophying*, *Withering*, *or Cicatricial Scirrhus.*—This form may occur at any age, but is more common in old than in young women. The tumour is of slow growth, and shows in an extraordinary degree the tendency to contraction, which is to a less extent met with in all forms of scirrhus. The affected breast is thus, in spite of the presence of the new growth, actually smaller than its fellow. The nipple is deeply retracted, and when the skin is implicated, the affected part may be drawn together like the scar of a burn. There is usually but little pain. The ultimate course of the disease is the same as in ordinary scirrhus, ending in implication of the lymphatics and infection of distant parts; but the average duration of life in cases not operated on is eighty-two months, patients having been known to survive fifteen, or even twenty, years.

(*c*) *Cancer 'en cuirasse.'*—This is a rare form of the disease. It commences in the mammary gland, usually as the ordinary nodular form, but more rarely as the atrophying. The peculiarity consists in the rapid extension in the skin as soon as the disease reaches the surface. This may take place by continuous extension, or numerous small flat tubercles may appear dotted round the central point at which the skin is implicated, and these gradually increase and coalesce. In one of these ways the whole skin of the front and side of the chest may be affected, from the clavicle to the level of the umbilicus. The skin becomes of leathery hardness and toughness, and of a dusky, brownish-red colour, and is tightly stretched over the parts beneath. Ulceration may occur in several points at the same time. This form of cancer is accompanied almost invariably by intense burning pain, and is usually speedily fatal.

Pathological Anatomy.—A typical scirrhus when removed is characterised by the hardness of its structure, the knife even creaking as it passes through it. The cut surface immediately becomes concave, in this respect differing from all other tumours. This is due to the degeneration of the cells and consequent shrinking of the central parts, while the contraction is limited by the density of the surrounding parts of the growth. The section is greyish-white in colour, and streaked by whitish or yellowish-white lines and dots, thus presenting the appearance of a section of an unripe pear. Its circumference is seen to be implicating the surrounding tissues, portions of undestroyed fat being frequently imbedded in the fully-formed cancer-tissue. On scraping or squeezing, it yields an abundant milky juice. In the infiltrating form the structure is more uniform, often lobulated, and of a white or pinkish-white colour. Its surface becomes less markedly concave when the breast is cut across, and it yields a more abundant milky juice. In the atrophic form the tumour is small, very dense, its surface becomes very markedly concave, and it yields but little juice on scraping.

The microscopic characters are fully described under cancer. *See* Carcinoma. It is sufficient to say here that the cells are arranged most commonly in lines or tubes in the denser forms, and in rounded spaces in the less dense varieties, especially in the infiltrating scirrhus, in which the structure is often spoken of as acinous. In the central part the cells are found to be undergoing fatty degeneration, and it is to this change that the shrinking is chiefly due.

Prognosis of Scirrhous Cancer.—The prognosis of scirrhous cancer is hopelessly bad, unless the patient be relieved by operation. The more active the growth, the more rapidly does secondary infection take place; thus, in ordinary nodular scirrhus, the average duration of life is only 27·1 months, while, in the shrinking or atrophic form it is as much as 82 months. Cancer '*en cuirasse*' is always very rapidly fatal. As a rule, the younger the subject the more active is the growth, and the shorter the duration of life; but this rule is not without exceptions. Pregnancy always adds greatly to the gravity of the case, for, as the mamma enlarges, the tumour increases with fearful rapidity. The effect of operation on prognosis will be discussed later on.

Encephaloid Cancer.—True soft cancer—that is to say, so soft as to justify the term brainlike—is very rare in the breast, as elsewhere. The so-called soft cancers of the breast are usually firm and elastic, lobulated, and of rapid growth; and every intermediate form is met with between them and the less dense varieties of scirrhus. Soft cancer occurs at the same age, and under the same conditions, as scirrhus. It most commonly infiltrates the whole gland rapidly, but occasionally remains limited to one part. The tumour reaches a considerable size in a few months, causing, from an early period, an evident enlargement of the gland. Retraction of the nipple is an occasional symptom, and is often more apparent than real, being due rather to the projection of the implicated tissues round it. Dilated veins are commonly seen over the distended gland, and there may be some abnormal redness of the skin. Manipulation shows the mass to be tense and elastic; not unfrequently there is considerable œdema of the subcutaneous tissue. In exceptional cases the central parts of the tumour may be broken down by hæmorrhage, and there may thus be distinct fluctuation. The progress of the case is the same as that of scirrhus, but greatly exaggerated and accelerated. The glands are early affected, the skin becomes implicated, ulceration takes place, with the formation of a deep foul cavity, from which hæmorrhage is very prone to occur. The tumour soon forms deep attachments, and secondary growths appear in the viscera and elsewhere. The general health suffers early and severely.

Prognosis.—The average duration of life in soft cancer of the breast is under one year. Even after removal of the breast it is said to be only sixteen and a half months, death being due either to local recurrence or secondary growths in the viscera or elsewhere.

Pathological Anatomy.—The tumour on section is of a uniform white or pinkish-white colour, sometimes stained in parts brownish or reddish-brown from hæmorrhage. The growth is often markedly lobulated; its cut surface is convex or flat. It yields a very abundant milky juice on scraping. Microscopic section shows the characteristic alveolar stroma filled with cells of an epithelial type. These may be of great size, or may differ but little from those of scirrhus, the essential difference being in the relative proportion of stroma to cells rather than in those structures themselves. In rare cases the stroma is excessively vascular, and vascular processes project from the walls of the alveoli into the spaces. It is in cases of this kind that the structure may be extensively broken down by hæmorrhage.

Colloid Cancer in the breast is very rare. It is merely a modification of scirrhus, due to colloid degeneration of the epithelial cells contained in the alveoli. In its early stages it differs in no respect from ordinary scirrhus, but the degeneration of the cells seems to retard the growth of the tumour. Gross states that the average duration of life, in cases not operated on, is 144 months. As colloid degeneration tends to increase the bulk of the growth, the tumour does not show the tendency to retraction which forms the marked feature of ordinary scirrhus. The nipple is not drawn in; the tumour, as it grows, assumes considerable proportions, and when it implicates the skin it forms a projecting nodule, often of considerable size, before ulceration takes place. When ulceration commences, it proceeds slowly, the surface being sometimes covered with a crust or scab formed of the dried colloid matter. Infection of the lymphatic glands and internal organs follows in due course, and the secondary tumours may have the structure of ordinary scirrhus or assume the form of colloid cancer.

Pathological Anatomy.—The whole tumour has very rarely been found to have undergone colloid degeneration. More commonly the peripheral parts present the ordinary appearance of scirrhus. In the degenerated part the alveolar spaces are distended with colloid matter, so as to be clearly visible to the naked eye. We thus get an evident alveolar stroma, filled with a transparent gelatinous material of a delicate or yellowish-pink colour. *See* Carcinoma.

Prognosis.—The prognosis of colloid cancer is ultimately bad, but life is prolonged, in cases not operated on, for a longer period than in any of the other forms of disease.

Duct Cancer or Villous Cancer.—This rare form of cancer of the breast was first accurately described by Cornil and Ranvier. It resembles ordinary cancer in infecting neighbouring parts, lymphatic glands, and distant organs. To the naked eye it somewhat resembles soft cancer, and yields an abundant milky juice. On closer inspection, small cysts are seen, partly filled by dendritic filaments projecting into the cavity, the remaining space being occupied by a milky fluid. Sometimes the milky fluid is replaced by extravasated blood. Microscopic examination shows that the spaces are surrounded by a fibrous wall, from which the branching papillæ spring. These are very vascular, and covered with epithelium arranged in several layers. It is either cylindrical or cubical, with a tendency to assume the cylindrical form. The milky juice contains the degenerated cells which have been cast off. From the resemblance of the epithelium to that lining the milk-ducts, it is highly probable that these spaces arise primarily from those structures, and hence the name 'duct cancer.' Billroth describes a growth apparently similar under the name of 'soft cysto-adenoma.' He says: 'If one looked at the specimen without knowing whence it came, one would think it might be from a polypus of the rectum or uterus.' When the growth is broken down by hæmorrhage, it closely resembles a soft sarcoma in appearance. The *clinical features* of the disease cannot yet be accurately defined. Some of the cases recorded have been taken for ordinary scirrhus, and some for sarcomata, before removal. The disease may be preceded by a bloody discharge from the nipple, as in duct-cysts. The prognosis is uncertain. Billroth's case occurred in a woman of twenty-four, and did not recur after removal. Other cases have run a malignant course, like that of ordinary cancer.

TREATMENT OF CANCER OF THE BREAST. No drug has as yet been discovered that exerts the slightest influence on the progress of cancer of the breast. The sole treatment which need be considered is the removal of the tumour, and this can only be effected by the knife or by caustics. Pressure, applied by means of various ingenious instruments, was at one time said to have caused the absorption of cancerous growths, but there is no trustworthy evidence that such a result has ever been obtained. Caustics have been extensively used by quacks and but little by surgeons. They are uncertain in their effect, it being impossible to be sure that the whole growth, and much less the whole gland, is removed. They are, moreover, extremely painful, and are quite inapplicable to cases in which the axillary glands are diseased. The removal of the disease by the knife is almost painless, is more speedy, and more certain, and no surgeon is justified in recommending the use of caustics as a substitute for it. It has been said that caustics are occasionally useful when the patient is either unfit to bear an anæsthetic, or too weak to stand a cutting operation. Such cases are equally unfit for caustics, and had better be let alone. The operation by the knife is therefore the only treatment we need consider.

Excision of the breast may be undertaken in all cases of cancer, while the disease is apparently limited to the mamma, unless contraindicated by diabetes, Bright's disease, extreme old age, or some other condition unfavourable to any surgical operation. Extreme fatness, although not alone a barrier to the operation, is an unfavourable condition, and, if combined with old age, is sufficient to render it inadvisable.

In the second stage of the disease, when the lymphatics and skin are affected, the operation may still be undertaken, if the diseased glands be limited to the axilla, and if the general health be good. The liver and other organs should always be carefully examined for secondary growths. In the third stage the mere fact of ulceration is of little importance. The question of operating must be determined by the general health, by the extent of the implication of the skin and lymphatic glands, and by the evidence of visceral infection.

The operation is contraindicated when both breasts are affected, when the glands above the clavicle are distinctly enlarged, when the glandular enlargement has caused œdema of the arm, when the deep adhesions of the tumour are such that there is reason to believe the chest-walls are implicated, and when the so-called cancerous cachexia is so manifest as to give rise to a suspicion of visceral implication.

The form of cancer also exerts some influence in determining the propriety of operating. The simple nodular scirrhus is always favourable for removal in its early stages; infiltrating scirrhus must be removed early, if at all, or it will most likely return locally; cancer '*en cuirasse*' is never suited for operation. Atrophying scirrhus and colloid cancer, being of slow growth, are favourable cases for operation. Encephaloid cancer, unless taken very early, may as well be let alone, as local recurrence is very prone to occur.

Should an operation be determined on, it is a universally received rule that the whole gland, including the nipple, should be removed. It is an equally well-recognised rule that, if the skin is implicated, the incisions must be carried very wide of the diseased part, and that, if the glands are enlarged, they must be removed at the same time as the breast. During the last few years many surgeons, amongst whom may be mentioned Küster, Banks, and Billroth, have strongly advocated the removal of the axillary glands in every case, whether any enlargement can be felt or not. The results of this practice have been such that there can be little doubt that it will before long become an established rule of surgery. Küster states that in one quarter of the cases treated in this way the patient has remained well three years after the operation, which he considers a sufficient time to justify the belief that the cure was permanent.

Before commencing the operation the skin of the axilla should be shaved. The patient must be placed on a table of convenient height, and the arm must be raised and retained in that position, either by a bandage or by the hand of an assistant.

The incisions must necessarily be varied according to the situation of the tumour and the degree of implication of the skin. The operation is most commonly done by two curved incisions, including between them the whole of the skin covering the tumour. These incisions are so placed that the long diameter of the oval piece of skin included between them is parallel to the fibres of the pectoralis major. It will be found, however, that better drainage is obtained if they are so arranged that the long diameter is transverse, the angle of union of the two incisions being on the inner side near the sternum, and on the outer side at the lower part of the anterior fold of the axilla. If the oblique incision is adopted, the lower flap must be raised first, so that blood flowing from the upper may not inconvenience or obscure the view of the surgeon. In raising the flaps enough fat must be taken to ensure their vitality, and no more. It is advisable to remove the greater part of the fat about the gland with the breast. The dissection must be continued till the border of the gland is passed, and then carried more deeply till the fibres of the pectoralis major come into view. The other flap is then raised in the same way. Finally the whole breast is removed, the knife being carried along the fibres of the muscle so as to remove the fascia covering it with the breast. The whole operation should be done by clean dissection, with as little tearing as possible. Every bleeding vessel should be immediately seized when cut, by forci-pressure forceps, so as to diminish the loss of blood. The mass removed must then be carefully examined, and, if any lobule of the mamma has been left behind, it must be dissected out. If the tumour is adherent to the pectoralis major, it is better to remove the muscular tissue freely, either with the breast or afterwards.

Should it be intended to remove the glands, the axillary space must now be freely opened up. During this stage of the operation the arm must be held by an assistant, as the surgeon often requires to vary its position as the dissection is carried on. If the oblique incision has been adopted the axilla may be opened by carrying the knife upwards from the upper angle of the wound to the arm. If the transverse incision has been chosen, a cut must be made from near its outer end upwards to the arm, along the anterior border of the axilla. The glands should then be removed, with the fat of the axilla, by a process of careful dissection. It should be commenced at the anterior border and carried upwards, a blunt instrument being used as the axillary vein is approached. Any doubtful bands appearing to contain vessels should be tied with catgut ligatures before being divided. In this way the axillary vein is reached and exposed, and the upper part of the contents of the axilla freed. The dissection can then be carried downwards and backwards, care being taken to avoid the subscapular artery and vein, if possible. Unless a sharp look-out is kept for these vessels, they may be cut so close to the main trunks that a ligature can scarcely be applied, and it might thus become necessary to ligature the axillary artery. The intercosto-humeral nerve is divided, and usually the external mammary artery. A small gland, often found between the edges of the two pectoral muscles, should be sought for and removed. The thorough cleaning out of the axilla requires care and patience, but is not specially dangerous. The danger of entrance of air in an accidental wound of the axillary vein, or of a large branch entering it, must not be forgotten. *See* Air in Veins. The plan sometimes adopted of opening the axillary fascia and hooking out such glands as may be felt with the finger, is far less efficient than that just described. When it is adopted, more glands are usually left behind than are removed.

The after-treatment of the wound presents nothing peculiar. Drainage must be carefully provided for by the insertion of tubes. Button sutures must be used to bring the edges of the main wound together if there is much tension. Antiseptic treatment of some kind should be adopted whenever possible. The spray is perhaps the most efficient means of irrigation during the operation; but, if the surgeon prefers not to use it, the wound may be washed out with carbolic acid lotion (1 in 40), tr. iodi and water (f ʒij. to Oj.), bichloride of mercury (1 in 1,000), or chloride of zinc (20 gr. to f ʒj.) before the stitches are inserted. The dressing should also be antiseptic, but the form adopted must vary with the preference of the surgeon. Carbolic gauze is well adapted to most cases. Very good results are also obtained by permanent dressings of salicylic wool or iodoform wool. *See* ANTISEPTIC SURGERY; WOUNDS.

Results.—The mortality from the operation is very small. When death does occur it is most commonly from pyæmia, septicæmia, or erysipelas. There are no dangers peculiar to the operation.

But few patients, however, are cured. It is generally recognised that life is lengthened, and that in many cases an easier death is substituted for that from ulceration and exhaustion. The statistics at present before the profession show that life is prolonged by the operation—in scirrhus by about twelve months, and in encephaloid by about eight months. These are, however, of little value. In order to draw any just conclusions, those cases which are operated on merely to give relief should be excluded. A separation should also be made between those in which the axilla is cleared out, and those in which the breast only is removed. There is no doubt that the more extensive operations performed at the present time give much better results, but the numbers recorded are not at present sufficient to draw any accurate conclusions from them.

When recurrence takes place, it may be in the scar, in the glands, or in distant parts. If the axillary glands have not been removed before, they may be taken away when the recurrence appears. If they have been removed and the recurrence is above the clavicle nothing can be done. Recurrences in the scar are best avoided by the freest possible removal of skin at the operation. Should they occur, great relief is often given by their removal, but any permanent cure is out of the question.

The *treatment of cancer not operated on* is very unsatisfactory. Antiseptics should be applied as soon as ulceration sets in, to correct the offensive odour. Among the best of these is an ointment composed of eucalyptus oil, ♏xx., iodoform gr. v., and vaseline ℥j. Carbolic acid is often too irritating; boracic-acid lint, terebene and oil, and washing with Condy's fluid are often useful. Conium poultices have been said to relieve the pain. Possibly cocaine might be of service. Sooner or later it is usually necessary to fall back on opium, given internally. It is most efficiently administered as hypodermic injections of morphia.

DISEASES OF THE MALE BREAST.—The male breast is but little subject to disease. Mastitis neonatorum (see *Mastitis*) is equally common in the two sexes, and at puberty some swelling of the rudimentary gland is not uncommon. In adult life the breast is occasionally chronically inflamed, enlarged, and indurated. This is best treated by the application of belladonna. If this fails, tincture of iodine may be tried, and, as a last resource, if the tenderness and inconvenience are considerable, the whole gland may be excised.

Cancer of the Male Breast is occasionally met with. It appears almost invariably as scirrhus, and runs the same course and requires the same treatment as in the female. MARCUS BECK.

BREAST, Tumours of the, Diagnosis of.—In examining the breast for any disease the whole gland must be fully exposed. Neglect of this precaution is a common cause of errors of diagnosis. The patient should be in the recumbent position, so that the breast may be well supported by the ribs; in the erect position elasticity or fluctuation are readily overlooked. The diagnostic signs of the various growths differ so much in the early and late stages, that it is convenient to divide the tumours into (A) large, or those exceeding a large orange in size; (B) medium-sized or those between an orange and a walnut; and (C) small. Of course all tumours are originally small, and in this stage diagnosis is most difficult; but many never reach any great size, and others cause so little inconvenience that the patient allows them to attain a considerable bulk before consulting the surgeon. Unfortunately also, many are still allowed to increase to the medium or even large size by the pernicious practice of waiting till the nature of the growth becomes evident. If the surgeon is in any doubt, it is his duty to advise the patient to have the tumour examined by incision. When the nature of a malignant tumour becomes so clear that a mistake is impossible, it is usually too late to operate with any hope of permanent cure.

(A). LARGE TUMOURS OF THE BREAST.

1. *The tumour arises in connection with lactation.*—Galactocele. Milk can be withdrawn by the aspirator. *See* GALACTOCELE.

2. *The tumour does not arise as a consequence of lactation.*

(*a*) *It is of more than twelve months' growth, and the axillary glands are not enlarged.*—(*α*) Adeno-sarcoma, and (*β*) cysto-sarcoma.

a. Adeno-sarcoma—Does not implicate the mammary tissue; is smooth, elastic, lobulated, clearly defined in outline; not adherent to the skin, unless of great size; may fluctuate in parts and is painless. The nipple is spread out, but not retracted or buried. It often arises by a sudden increase of growth in a very chronic tumour; it is most common between thirty and forty.

β. *Cysto-sarcoma.*—Closely resembles the adeno-sarcoma, but is more lobulated, and the fluctuating cysts are more distinct and numerous. It is of slower growth, and occurs most commonly between thirty and fifty.

(*b*) *The tumour is of about twelve months' growth, and the glands are not enlarged.*—Sarcoma.

Sarcoma.—Does not usually infiltrate the gland; is clearly defined, but less so than adeno-sarcoma or cysto-sarcoma; is elastic or semi-fluctuating, smooth or coarsely lobulated on the surface. It is of rapid growth and painless. The nipple is not retracted or buried. The skin is not implicated till late. It is most common between thirty and forty.

(*c*) *The tumour is of less than twelve months' growth, and the axillary glands are enlarged.*—Encephaloid cancer.

Encephaloid cancer infiltrates the gland. It has an ill-defined outline; its surface is lobulated; its consistence varies from semi-cartilaginous, elastic hardness to almost fluctuating softness; the skin covering it is early fixed to it and often œdematous, sometimes red; it is of very rapid growth and usually painful; the nipple is early buried by the swelling rather than retracted; the growth is adherent to the deep parts. It is most common between forty and fifty, but may occur at any age after thirty.

Dilated veins over the surface of the breast occur in all large tumours, and are of no diagnostic value. Ulceration may occur in all, but it takes place soonest in encephaloid cancer. The formation of a vascular, prominent, fungous mass is evidence of the sarcomatous nature of the growth. Cancer sloughs rather than fungates, forming a deep, foul excavation.

(B). MEDIUM-SIZED TUMOURS.

1. *The tumour does not implicate the mammary tissue, and can be moved without dragging on the nipple.*—(*a*) Adeno-fibroma, (*b*) adeno-sarcoma, (*c*) cysto-sarcoma, (*d*) fibroma, (*e*) sarcoma.

(*a*) *Adeno-fibroma.*—It is of slow growth, rounded or slightly lobulated, dense and hard, inelastic; may be painless, but is often painful. It is most common under thirty.

(*b*) *Adeno-sarcoma* closely resembles an adeno-fibroma, but is of more rapid growth, perhaps following a long period of slow growth and being less dense. It is more common between thirty and forty.

(*c*) *Cysto-sarcoma* cannot be distinguished from an adeno-sarcoma at this stage, unless the cysts cause very distinct lobulation and can be recognised by fluctuation.

(*d*) *Fibroma.*—A pure fibroma cannot be distinguished from an adeno-fibroma.

(*e*) *Sarcoma.*—A sarcoma is less clearly defined than the foregoing tumours; it is softer, sometimes elastic or semi-fluctuating, seldom lobulated, painless, and of rapid growth. It occurs commonly between thirty and forty.

At this stage none of the foregoing tumours form deep adhesions, they do not cause enlargement of the glands, and produce no deformity of the nipple. They are not adherent to the skin.

2. *The tumour implicates the mammary tissue, so that the nipple is dragged on when the growth is moved away from it, and connection by means of the ducts can be felt.*—(*a*) Cysts; (*b*) Cancer.

(*a*) *Cysts.*—These are painless, of slow growth, fluctuating or elastic, or sometimes so tense as to be of almost stony hardness. They are smooth on the surface or coarsely lobulated. The skin does not dimple over them, nor is there œdema. If one part can be felt to be softer or more elastic than the rest it is the centre. They are most common between thirty and forty.

The chief kinds of cysts are—*a. Glandular or duct cysts* are often multiple; their contents can sometimes be emptied from the nipple by pressure, or there may be a history of a bloody discharge at some time.

β. *Serous cysts* cannot be emptied by pressure, and are usually single.

γ. *Hydatid cysts* cannot be recognised without puncture.

If there is any suspicion that the tumour is cystic it should be punctured with a fine trocar. If the contents are brown and bloody, it is, probably, a glandular or duct cyst; if clear and rich in albumen, it is, probably, a serous cyst; if clear and nearly free from albumen, a hydatid cyst. The fluid must then be searched for hooklets. Hydatid cysts are very rare.

(*b*) *Cancer.*—Cancer, in this stage, is adherent to the skin, as shown by dimpling when the integuments are pinched up, or may be actually implicating the skin, or even ulcerating. It is very painful, the pain being lancinating and burning. It is but slightly tender. It is of rapid growth. The nipple is very frequently retracted. The tumour may be fixed to the deep parts and the axillary glands are enlarged.

The different forms of cancer are thus distinguished.

α. *Scirrhus* is very hard, the centre being the hardest part; its outline is tolerably clearly defined, but not sharply circumscribed; its surface is usually nodulated; it very rarely forms a medium-sized tumour without implicating the skin and glands. The nipple is almost invariably deeply retracted, especially if the tumour be near the centre of the gland. The duration of the growth is usually about a year before this size is reached. It is very painful.

β. *Soft cancer* is elastic, very ill-defined; its surface is smooth or lobulated; it is often less painful than scirrhus; the nipple is less frequently retracted. It may reach a medium size without actually implicating the skin, but there is dimpling over it if the integuments are pinched up. The axillary glands are early implicated. It rarely lasts six months without reaching a medium size.

γ. *Colloid cancer* is almost painless, and of much slower growth. It is lobulated and elastic, the outer parts being sometimes harder than the centre. It causes the same dimpling of the integuments when pinched up, and, when implicating the skin, may form a considerable projection without ulcerating. The nipple is rarely retracted; the lymphatic glands are enlarged. It may take two years or more to reach a medium size.

In medium-sized tumours, if there is any doubt as to the nature of the growth, an incision must be made into it, but this is less frequently required than in small growths.

(C). Small Tumours.—In addition to all the tumours before mentioned, which must at some time be small, there are three which never pass beyond this, the small size: chronic induration from mastitis, chronic encysted abscess, and atrophic scirrhus. The diagnosis of the small tumours is conducted on the same principles as that of the medium-sized.

1. *The tumour does not implicate the mammary tissue. Adeno-fibroma, adeno-sarcoma, cysto-sarcoma, fibroma, and sarcoma.*—These cannot be distinguished from each other in this stage, unless the points already mentioned can be made out.

2. *The tumour implicates the mammary tissue.* (*a*) Cyst. (*b*) Chronic inflammatory induration of a lobule. (*c*) Chronic encysted abscess. (*d*) Cancer.

(*a*) *Cysts* present the same features as when they are larger, but the difficulty in recognising them is far greater.

(*b*) *Chronic induration of a lobule.*—The indurated lobule is ill-defined, of leathery hardness, often nodulated from the pressure of small retention-cysts; the integuments do not dimple over it when pinched up, except when the lobule is very near the surface, in a thin subject. The skin is never implicated, nor is the nipple retracted. The tumour is of very slow growth and after a time becomes stationary. It is sometimes painful and often tender, especially at the menstrual period. There is no enlargement of the axillary glands. It occurs most commonly in women who have borne children, but may be met with in others. It may occur at any age, but becomes less common after forty-five. Several such lobules may be found in the same breast, and both sides may be affected.

(*c*) *Chronic Encysted Abscess* closely resembles the indurated lobule just described, but it arises almost invariably after lactation or after a miscarriage, and there is usually some slight œdema of the skin over it. Dimpling of the integuments on pinching them up is common. The induration is usually leathery, but if the contents of the cavity are at some degree of tension it may be of stony hardness.

(*d*) *Cancer*, when very small, is recognised by the very early dimpling and the stony hardness. It may occur at any age over thirty. There is usually no actual implication of the skin, no retraction of the nipple, no enlargement of the glands, no deep fixity of the tumour, and most frequently no pain—in fact, few of the signs which are certainly diagnostic of cancer. Should any of them be present with a small tumour their importance is greatly increased.

The early stages of a soft cancer or a diffused scirrhus are still more difficult to recognise, as they so closely resemble inflammatory induration. Primary cancerous tumours are almost invariably single. Atrophic scirrhus is usually easily recognised by the slow progress of the disease, the great retraction of the nipple, the scar-like shrinking of the affected skin, and the stony hardness of the growth.

The diagnosis of small tumours is thus very uncertain, and yet if the disease is malignant the only hope of cure lies in early recognition of its nature. In these cases, therefore, an exploratory incision should always be made. If the tumour is one of the simple growths, its smooth surface will be seen as soon as the capsule is opened and the mass can be turned out without difficulty. If it is a sarcoma its soft structure and less perfect outline will be recognised. If it is a cyst or an abscess the contents escape; and if it is an indurated lobule, its leathery toughness and perhaps the small retention-cysts will be recognised. If it is a scirrhus, the creaking of the knife as it enters it, and the sensation like cutting an unripe pear, and its sharp hard edge, not separable from the surrounding tissues, clearly show its nature.

If the case is a very doubtful one a freezing microtome and a microscope should be at hand, and a section should be mounted from a small slice taken from the growth. In this way all doubts are set at rest. 'Waiting till symptoms develop' in the case of cancer means waiting till all hope of cure is gone.

The difficulties of diagnosis are so great that it is a good rule, even if the cancerous nature of the growth seems almost certain, to cut into it before removing the whole breast. Many accidents might have been prevented by adopting this simple precaution. *See* Breast, Diseases of the.

Marcus Beck.

BROAD LIGAMENTS, Diseases of the.—The broad ligaments may be the seat of inflammatory deposits (cellulitis), of abscess, of hæmatocele, of solid neoplasms, and of a variety of cystic tumours. The inflammatory deposits, abscesses, and hæmatoceles will be dealt with in the special articles—Pelvic Abscess; Pelvic Cellulitis; Pelvic Hæmatocele.

The Solid Tumours are very rare, and are so closely incorporated with either uterus or ovary that they are usually confounded with growths of those organs. It is, however, quite certain that fibroma, fibro-myoma, sarcoma, myxoma, and lymphadenoid tumours may grow in the broad ligament, independently of both uterus and ovary. The myxomatous and lymphadenoid growths may attain an enormous size and closely simulate like tumours of the uterus. Their causes, symptoms, diagnosis, and treatment cannot be at present separated from those of the latter growths, except that it may be possible to enucleate them without removing either the uterus or ovary.

Cysts.—These are very important, not only from their growth frequently demanding surgical interference, but also from their great pathological interest.

Causes.—These are as obscure as are those which produce ovarian cysts. The great majority, if not all, probably receive their first impetus from the congestions and inflammations to which the ligaments are exposed.

Pathology.—There are several varieties of broad ligament cysts.

1. *Cysts arising from distension of pre-existing structures.*—The hydatid of Morgagni, found as a small, clear cyst depending from one of the fimbriæ of the Fallopian tube, arises from the remains of Müller's duct. A similar small cyst, which may be either sessile or pediculate, is frequently found at the outer end of the horizontal tubule of the parovarium. Small cysts also grow frequently from the vertical tubules of the parovarium, and these, with the sessile variety from the horizontal tube, may attain considerable size and require surgical treatment.

2. *Cysts arising in the cellular tissue, possibly due to blocking and distension of lymphatics, but not arising in definite pre-existing structures.*—These are the simple serous cysts of the broad ligament, and are identical with the sub-peritoneal cysts in other situations, often spoken of as 'inflammatory cysts of the peritoneum.' They may be unilocular, multilocular, or multiple. The unilocular may be so from its earliest growth, or may become so from coalescence of multilocular or multiple cysts. The latter may be found side by side, but quite independent, so that each is really a unilocular cyst. The part of the broad ligament between the ovary and uterus is liable to a general cystic degeneration, apparently the result of œdema; it is not a condition of much practical importance, except in so far as it sometimes interferes with the application of the ligatures in the removal of ovarian or uterine tumours.

3. *Papilloma-bearing cysts.*—These are of great importance, because the possibility of the presence of such growth in any broad ligament cyst governs the whole surgical treatment of these cysts. Doran has recently thrown much light upon the origin of these cysts, and has shown that they commonly arise from the vertical tubules of the parovarium, and especially where these tubules penetrate deeply into the hilum of the ovary. It is still, however, an undecided question whether papilloma is only found in cysts with this origin, or whether it may arise from the lining membrane of any cyst. And it is equally uncertain why one kind of papilloma-bearing cyst produces an innocent warty growth, which, though it may spread and infect other surfaces, often dies away entirely after a successful removal of its parent cyst, and another form is distinctly malignant. The hard, white, warty papilloma is commonly found in these parovarian and hilum cysts from their earliest growth; but the more fleshy pink papilloma appears in flat patches

on the lining membrane of cysts which have been allowed to remain undisturbed for long periods, or have been repeatedly tapped. Possibly in this difference as to the time of their first appearance may ultimately be found the reason of their clear clinical divergence.

The cysts which arise at the terminal ends of ducts, and the simple serous cysts have a simple lining of flat endothelium, and their fluid contents vary in colour from pale straw to orange and dark coffee colour, the latter being due to the admixture of blood. The ordinary parovarian cysts, and those which contain the warty papilloma, have a clear limpid fluid like water.

Diagnosis and Treatment.—An imperfect knowledge of these broad ligament cysts has led to two considerable errors as to their diagnosis and treatment. The first of these is the common one of speaking of the whole class as parovarian cysts, whereas the simple serous cysts are commoner than the true parovarian; the second is the commonly received opinion that they all may be cured by simple tapping. There are probably two causes for this second error: first, the fact that any of these cysts may fill very slowly after tapping, and, in the long interval, pass altogether out of the knowledge of the surgeon who performed the operation; and, secondly, that simple serous cysts are occasionally cured by a single tapping.

The only points which aid the diagnosis of these cysts from those of the ovary are their slow growth and occasional flaccidity, or this latter condition alternating with a more tense one. As it is impossible to be absolutely certain whether any given cyst is a simple serous one, or contains the infecting papilloma, they should never be tapped either for diagnostic purposes by examination of the fluid, or with a view to possible cure. They are generally free from adhesions, and can be removed with but little risk. Occasionally a broad base may necessitate a difficult enucleation, but these cases also do remarkably well, if care be taken to check all hæmorrhage, and the sides of the capsule be allowed simply to fall together at the bottom of the pelvis—i.e. if the operation be thoroughly aseptic; if it be not so, a glass drainage-tube should be left in the capsule for the first day or two, as there is often a good deal of serum effused from its torn cellular tissue.

It is sometimes possible to remove the cyst and leave the ovary and tube; but this is rarely advisable, as both are apt to be altered by the stretching during the growth of the cyst, and are liable to become diseased. The preparation of the patient, the arrangements for the operation, the instruments required, and the treatment after operation, are in nowise different from those for OVARIOTOMY, and will be found described in detail in the article on that operation. J. KNOWSLEY THORNTON.

BROMIDROSIS.—*Syn.*: Osmidrosis; stinking sweat.—A functional disturbance of the sweat-glands, causing the sweat to be so altered in character as to give rise to an abnormal odour. It is sometimes accompanied by hyperidrosis.

Symptoms.—The condition may involve the whole of the surface, or be of a local character. When universal, the individual emits with perspiration an odour which may be like that of a goat, or like that of onions or assafœtida, or it may be simply disgusting and indescribable. Sometimes a rather pleasant odour is noticed, like that of violets.

Bromidrosis is frequently the accompaniment of systemic diseases—smallpox, typhus, rheumatism, pyæmia.

The local varieties of bromidrosis are met with chiefly in the parts which sweat freely—the axillæ, groins, perineum, genitals, soles of the feet; here it is probable that decomposition of the sweat and sebaceous secretion is mainly instrumental in producing the result. The confinement of the sweat by waterproof clothing, dress-preservers, &c., tends to make matters worse. Bromidrosis of the feet is that form which most often calls for treatment. When associated with hyperidrosis, the treatment by Hebra's ung. diachyli, described under HYPERIDROSIS, may be adopted.

A mode of treatment has been suggested by Thin which seems to be very efficacious. It consists in soaking the stockings or socks every night in a saturated solution of boracic acid. Cork soles should be worn in the boots, and treated in a similar manner.

A solution of chloral to bathe the feet, 10 to 40 grains to the ounce, is also recommended. ALFRED SANGSTER.

BROMINE. *See* CAUSTICS.

BRONCHOCELE. *See* THYROID GLAND, Diseases of the.

BRONCHOTOMY. *See* TRACHEOTOMY.

BRUISES or CONTUSIONS.—These result from injury to the tissues caused by blows or squeezes. Structures may thus be so damaged as entirely to lose their vitality, so that sloughing or gangrene results. It much more commonly happens that the injury is of a less severe nature, being confined to the rupture of some small superficial vessels, leading to an extravasation of blood. The slighter cases are only here considered, the severer ones being found under the heading of gangrene. The blood oozing out from the ruptured vessels finds its way into the interstices of the connective tissue, both of the skin and subcutaneous fascia. In addition to the blood there is considerable effusion of serum stained with the colouring-matter of the corpuscles. Soon after the receipt of the injury the part becomes swollen, and assumes a semi-transparent, pinkish appearance.

Occasionally, after a while, large bullæ are formed beneath the cuticle, containing blood-stained fluid. As the serum is reabsorbed the swelling decreases, but the colour of the part becomes darker, passing, in the course of a few days, from a dull red to a dark brown or chocolate, and then, slowly fading away, it assumes a greenish-yellow colour. The extravasation of blood generally ceases to extend after a few minutes; sometimes, however, the effusion slowly continues for some hours, extending over an area considerably larger than the part actually injured. The bruised part may inflame, giving rise to suppuration; but this is rarely the case, unless the skin has been broken, thus making a compound contusion.

In some instances, instead of the blood forming an infiltration into the connective tissue, it forms a circumscribed collection beneath the skin. This is known as a hæmatoma. The contained blood does not coagulate, so that a soft fluctuating swelling results. The tendency to the formation of bruises or blood-extravasations varies widely in different individuals, and the extent of the discoloration is no certain indication of the amount of violence employed. Some persons with thin, delicate skins, or with a tendency to the hæmorrhagic diathesis, will have their tissues bruised and discoloured from the most trifling injuries, a fact which should be borne in mind in certain medico-legal enquiries.

Treatment.—This should be of the simplest kind. To suppose that the effects of a contusion can be at once removed by the application of stimulating or any other lotion is absurd, for time is required for nature to absorb the extravasated blood and repair the injured tissue. Irritating lotions, and either very hot or cold applications are especially injurious, for it must be remembered that the vitality of the skin is already lowered, and it will be liable to slough, or become gangrenous if subjected to irritation. Just at first, whilst there is a tendency for the swelling and extravasation to increase, cold fomentation or spirit lotion may be advantageously employed; afterwards, the part should be kept warm and protected from pressure. With this object it may be lightly covered with cotton wool, and kept in position with a flannel bandage. Should blebs form, they may be pricked, and a piece of oiled lint applied beneath the cotton wool.

Arnica lotion has enjoyed some reputation in removing the discoloration; possibly, by stimulating the blood-supply, it may occasionally have this effect, but it generally does more harm than good, often producing excoriations and eczema.

Should the damaged skin slough, a light poultice may be applied, to protect the injured part and hasten its separation. If the extravasation should take the form of hæmatoma, this may be treated by moderate pressure applied with a bandage. Under this treatment, the collected blood frequently becomes reabsorbed. Should it not do so after some weeks, the swelling, with antiseptic precautions, may be aspirated.

Harrison Cripps.

BRUSH-BURN.—This name has been given to a peculiar and complex injury caused by rapid and forcible friction of the surface of the body. It may be produced either by some rapidly revolving body, as a strap connected with machinery, coming in contact with the skin, or by the surfaces of the trunk and limbs gliding with much velocity down a long descent, such as an Alpine snow-slope. The skin is abraded, much bruised, separated from the subjacent soft parts, and sometimes actually burnt by the action of the heat developed by the friction. The subcutaneous connective tissue and the fasciæ and muscles are often much contused. In consequence sometimes of the burning, but more frequently of the cutting-off of its blood-supply, the injured portion of skin becomes gangrenous and is converted into a slough. The injury when extensive is a very painful one and attended with much collapse.

The treatment should consist in applying anodyne fomentations over the contused skin and, if this undergo sloughing, in dressing the eschar frequently with some stimulating lotion or ointment. The granulating surface exposed on separation of the eschar is to be dealt with in the same way as any large healthy ulcer.

W. Johnson Smith.

BRYANT'S SPLINT, for excision of the hip and fractures of the thigh, is a compound of two long splints, one for each lower limb, fixed together at the upper and lower ends—at the upper by an iron bar which arches across the chest, and at the lower by an iron rod which passes straight across below the foot-pieces. The foot-pieces slide in slots at the lower end of the splints, and to each is attached a cord passing over a pulley, by means of which it is directed along the outer side of the splint, where it is attached to an elastic accumulator. By means of a piece of wood with a hole at each end, similar to those used for tightening tent-ropes, which is placed on the cord, it is possible to put the accumulator on the stretch and so cause traction on the foot-piece, and the use of the double splint is thought to ensure perfect symmetry of the two limbs. BILTON POLLARD.

BUBO.—A bubo, in the original use of the word, was any glandular swelling occurring in the groin. The term has, however, been extended to include gland-swellings in other parts, and it has been restricted to those which are secondary to sores existing elsewhere. Conventionally, a further limitation is often made, and we employ the word to denote only gland-enlargements which are secondary to venereal sores. In popular use, and probably with nine-tenths of the profession, the word now has only the latter meaning, and it might avoid confusion if it were in the future so restricted. The classical 'buboes of the plague' will probably long retain their name, but it is rapidly becoming pedantic to call enlarged glands 'buboes,' unless we mean that they are due to venereal disease.

The character of the venereal bubo is determined by the nature of the sore itself. If the latter be inflamed and suppurating the bubo will probably partake of the same features; the glands will swell largely and the cellular tissue around them will be implicated. Thus the glands will be glued together, and an ill-circumscribed painful mass will result. Such buboes have a tendency to suppurate. The matter frequently forms first around the inflamed glands but not in them, and the latter may be laid bare by the destruction of the intervening tissue. In other cases, however, suppuration undoubtedly takes place in the glands themselves, which, one after the other, may soften and break down. Individuals differ very much as regards their liability to lymphatic implication, but with our modern improvements in the treatment of chancre and of syphilis we may now boast that suppurating buboes are very rarely seen. They occur for the most part when the primary sore has been neglected.

If the primary sore be indurated and not inflamed, then we must expect induration only of the affected glands. The hardening will probably implicate several of them, but it will not involve the intervening cellular tissue. The glands will remain isolated from each other, and will be probably scarcely at all painful. They may be rounded and very hard—the 'bullet bubo'—or elongated and only moderately firm—the 'amygdaloid bubo.' In the case of the infective chancre it is rare to have the glands inflame and suppurate, and this never occurs unless the sore has itself inflamed. It is said that when suppuration occurs in a bubo consequent on an infecting sore, the pus is not contagious, but it is obviously not possible that we should possess much knowledge on this point. The induration of the glands consequent on the infecting sore is often very prolonged, and lasts, in a minor degree, long after other symptoms of syphilis have disappeared. It has been suggested that in such cases the glands serve as reservoirs for the virus and take an important share in the production of relapses. Although this is mere conjecture, yet it may be fully admitted that it is a wise precaution to continue treatment until the gland-enlargements have quite disappeared. It must be remembered, however, that a certain degree of enlargement of the glands in the groin is the normal condition with some persons.

Occasionally, at long intervals—a year or even more—after the primary sore, glands which were at the time slightly enlarged, will take on fresh engorgement and suppurate. In these cases the buboes are in part of constitutional origin, and further mercurial treatment is generally required.

Although it is certain that the bubo in connection with an indurated chancre will occasionally suppurate, yet this is very exceptional. It occurs solely when the chancre is on the genitals and the bubo in the groin. In the case of erratic chancres, as on the lip from kissing, or on the finger from inoculation in midwifery practice, although the gland-enlargement may be very considerable, it very seldom, or perhaps never, ends in abscess. In the groin the glands are very superficially placed, and are especially liable to be bruised or irritated by external causes, and hence probably the increased risk of abscess there.

The *treatment* of the bullet bubo of the infective chancre resolves itself into the treatment of syphilis. Mercury must be freely given and cannot be begun too soon. The patient must be told to carry nothing in his trousers' pockets, and if the glands are more than usually large, he must not walk much. The treatment of the bubo which attends the non-infecting sore is a matter of much more difficulty. The main point is of course the treatment of the sore itself. This must be rendered healthy as soon as possible. Next, every possible cause of external irritation must be carefully avoided and rest enjoined. Since the tendency to suppuration is often a constitutional matter, the patient's health must be sustained by tonics and a liberal diet, or in critical cases by sea air. To the groin it may be well, so long as there is hope of repression, to use ice or evaporating lotions very freely, but in many cases warmth will be attended by better results. A hot poultice, by relieving pain and tension, will often favour the subsidence of inflammation, whilst if suppuration have occurred it will hasten its progress towards the surface. If, therefore, suppuration appear inevitable, it is better to poultice at once. The question will now arise as to the propriety of excising the affected glands. If they are large and isolated, or if they have been exposed by suppuration around them, it is certainly good practice to give an anæsthetic and to proceed systematically to their removal. If they are left they will often be very slow to subside and may give much trouble. Their enucleation, however, is by no means always an easy matter, and it is indeed seldom practicable to make the operation a complete one. It is always, however, well in opening a bubo to make the incision a free one and to scrape away as much of the gland implicated as possible. Sometimes the glands within the brim of the pelvis are also enlarged. In such cases sea air and the free use of tonics in combination with mercury are indicated.

As regards the precise position of the glands implicated, this is to be explained entirely by anatomical knowledge. It is to be remembered, however, that the lymphatics inosculate freely and are by no means always regular in their course. We must, therefore, allow for buboes which appear to deviate somewhat from rule. Thus a sore on the right side of the glans penis may produce a bubo in the left groin, or *vice versâ*, because the lymphatics often cross in the dorsum of the penis.

The term 'double bubo' is used when the gland-enlargement is on both sides. That of 'bubon d'emblée,' or primary bubo, is applied to cases in which a bubo appears without any chancre being discovered. A 'sympathetic' bubo is a misnomer for a gland-enlargement which is supposed not to be in direct connection with the peripheral cause, i.e. not due to absorption. As a matter of fact all true buboes are due to absorption of some kind. The terms acute, indolent, indurated, constitutional, &c., as applied to buboes, sufficiently explain themselves.

In certain constitutions it is quite possible for a bubo to arise from common non-specific balanitis. So also we occasionally have buboes in connection with gonorrhœa. In such cases the general rules of treatment will be the same as for those which occur in connection with non-indurated sores.

Jonathan Hutchinson.

BUBON D'EMBLÉE.—A term implying 'primary' or 'non-consecutive' bubo, was given formerly, by some French writers on syphilis, to a supposed form of suppurating bubo with inoculable secretion, arising quite independently of any primary venereal or syphilitic sore, and followed by manifestations of general syphilis. The existence of such a lesion as this is now almost universally denied, as it is opposed to the widely-accepted views that the syphilitic virus never penetrates an unbroken surface, and that the suppurating bubo with inoculable discharge is always associated with a non-infecting sore, and never in itself causes constitutional infection.

BUBONOCELE.—This term, now seldom used, has been applied to an oblique inguinal hernia whilst still retained within the inguinal canal.

BUCHANAN'S RECTANGULAR STAFF.—This staff, bent at right angles three inches from the point and deeply grooved along the short limb, was devised by Dr. Buchanan, of Glasgow, for use in his modification of median lithotomy. With this staff, it is held, the prostate may be reached by the knife more readily and rapidly, the membranous portion of the urethra need not be wounded, and there is less risk of injuring the rectum. The rectangular staff having been introduced, and its angle corresponding in position with the apex of the prostate being made to project into the perineum, a long and narrow knife with a straight blade is thrust along the groove in the short limb as far as the interior of the bladder, the rectum being protected by the forefinger of the left hand. The wound in the prostate is enlarged in an outward and downward direction as the knife is withdrawn.

BULLÆ or **BLEBS**, are blister-like elevations of the epidermis, varying in size from a split pea to half a turkey's egg, and containing fluid. In recently formed blebs the fluid contained is usually serous and of a clear pale straw colour; later on it becomes turbid, and sometimes dark red from the admixture of blood, or thick and yellow from the formation of pus. The fluid is always albuminous and generally alkaline in its reaction. Good examples of blebs are met with in pemphigus, and they may be artificially produced by the application of powerful irritants, such as cantharides or boiling water, to the skin.

Robert Liveing.

BUNION.—This term is applied to the enlarged and thickened bursa often met with over the inner side of the metatarso-phalangeal joint of the great toe, in consequence of the distortion which takes place there. By the constant wearing of narrow-pointed and short boots the toes, especially in women, are crumpled together, and the pressure on the inner side has the effect of dislocating outwards the two phalanges of the great toe. As these are driven outwards under or over the second or third toes, the head of the first metatarsal bone forms an increasing projection, and enlargement of the bursa naturally met with there takes place. *Pari passu*, the head of the metatarsal bone itself gradually enlarges, and presents small bony outgrowths similar to those met with in joints the site of osteoarthritis; the cartilage is absorbed, and the underlying bone becomes eburnated and sclerosed, the internal lateral ligament being elongated, while the external lateral is much shortened.

The chief troubles resulting from bunion are, first, the recurrent attacks of inflammation of the bursa, which cripple the patient while they last. After a while suppuration takes place, and the bursa, discharging, is liable to leave an ulcer, the healing of which is most tedious, owing to the liability to irritation, and the feeble circulation often met with after middle life, the period at which bunion comes chiefly under the notice of the practitioner.

Inflamed bunion, and still more the ulcer resulting from one which has suppurated, is very liable to render the patient subject to recurrent attacks of cellulitis and erysipelas, or even to become the starting-point of senile gangrene in aged or broken-down patients. If the ulcer open into the joint one variety of 'perforating ulcer' will present itself, leading to disorganisation of the joint and caries of the bones which enter into it.

Treatment.—One of the first things for the practitioner to insist on, a step which will, of itself, give sufficient relief in the early stages, is the wearing of proper boots, with straight inside border, rounded toes, giving sufficient room and play for the foot. The patient may be instructed to draw the phalanges inwards by passing a piece of Leslie's strapping between the first and second toes, around the phalanges of the first, and then carrying it along the inner border of the foot and round the heel as far as the centre of the outer side, this strip being secured by some others passed transversely round the foot and a bandage. A pledget of cotton-wool or 'elephant plaster' should be worn between the first two toes. Dr. Sayre recommends the use of a glove of buckskin or linen; this is fitted over the phalanges, and a few inches of elastic webbing attached to it, this webbing being itself fastened to a piece of strapping which goes round the heel, and is kept *in situ* as explained above.

If the case is too advanced for such simple treatment, some mechanical contrivance must be made use of. This consists of a metal sole-plate, which carries a delicate steel spring, by which the everted phalanges are gradually drawn inwards. Crumpled or hammer toes may at the same time be straightened by bandaging them with tapes to the sole-plate through slots in it. More conveniently worn than the above is the bunion-spring, made by various instrument-makers. The above should be worn by night as well as day. Where the phalanges are found too set or stiff to yield to gradual mechanical replacement, the surgeon may follow one of two courses. Aided by an anæsthetic, and with strict antiseptic precautions, he may divide the shortened external lateral ligament and any tendons, such as the extensor longus, which require it, and then forcibly but steadily replace the phalanges. If this be done too quickly the contracted skin on the outer side will very likely give way. Another, and probably better course is to perform osteotomy of the first phalanx, and thus bring the line of the great toe straight. But, in most cases of disorganisation of the joint, amputation by the oval method will be the wiser course, care being taken to secure ample flaps, and not to disturb the head of the metatarsal bone or the sesamoid bones, if sound.

The bunion itself will require various treatment, according to its stages and condition. When simple thickening of the bursa or effusion into it exist, counter-irritation by flying blisters, iodine, nitrate of silver (ʒj. to f℥j.), strapping with Scott's ointment or the oleate of mercury, may be tried. When the bursa is inflamed, lead lotion, conium, and bread poultices are indicated, together with the frequent and prolonged use of hot foot-baths, the treatment above given for the more chronic stage being later on resorted to. Where suppuration takes place an incision should be made early, otherwise the patient incurs the dangers of erysipelas, cellulitis, and troublesome burrowing. Furthermore, the ulceration which results from a suppurating bunion is, at this time of life, most tedious. Any undermined skin is to be snipped away, the cavity of the bursa laid freely open, and obliteration by granulations encouraged by absolute cleanliness and stimulating applications. With these objects in view, Ol. acidi carbolici (1 in 40), an ointment containing ʒj. of iodoform and eucalyptus oil to ℥j. of vaseline, and, later, more stimulating ones of Ung. resinæ and Tr. benzoini co., or Hyd. biniodi gr. x. to vaseline ℥j. (T. Smith), may be made use of. The weak circulation should be encouraged by warmth and elevation, and the healing promoted by occasional applications of weak nitrate of silver lotions to the granulations, which often become stationary for a while. Skin-grafting may, in some cases, be resorted to with benefit. In patients advanced in life small doses of opium will often be found beneficial, and in these cases warmth by means of cotton-wool, as little exposure as possible, and the raised position, are points of cardinal importance.

W. H. A. Jacobson.

BURNS.—Under this heading it is proposed to include all lesions that may be caused by the prolonged action of caloric on the surface of the body, and by the direct application to the living tissues of flame, steam, and intensely heated bodies, whether in a solid or fluid form. The injuries produced by the chemical action of caustics, and those known as lightning-strokes, will be dealt with in separate articles. *See* Lightning, Accidents from ; Caustics.

The term *Scald* is popularly applied to such injuries from caloric as are caused by heated fluids or steam. Between such injuries, however, and those caused by flame or heated solid bodies, no distinction can be made with regard to the nature of the changes produced in the tissues, or to their results and treatment.

The causes of burns and the ways in which caloric is applied to the body so as to produce injury vary much at different periods and in different countries, according to the habits and pursuits of the working classes of each people. The most frequent causes in this country are : the action of flame, the contact—more or less prolonged—of intensely heated solid bodies and fluids, and of fused metals, explosions of gas, and the impact of steam. In the United States and some parts of Germany burns are caused, in many instances, by the ignited vapour of certain mineral oils.

The injuries produced by the action of flame and highly-heated solid bodies are usually deep and destructive, whilst, in severe cases of scalding by heated water or steam, the gravity of the injury depends generally rather on the extent of surface involved than on the depth of the disorganisation. Scalds, however, that are caused by thick, oily, gummy, and saccharine fluids which adhere to the surface of the skin, and by boiling saline solutions are, as a rule, very destructive. The injuries caused by steam in 'boiler explosions' are usually very serious, in consequence of the extent of surface that is attacked, and of scalding of the mucous membrane of the respiratory tract. Of the more frequent forms of injuries from caloric, the most dangerous are those produced by the flame of burning clothes and by ignited gas. Rapid and deep disorganisation is the usual result of the contact of red-hot and fused metals, and of phosphorus and sulphur in a state of ignition; but injuries of this kind are usually confined to a small extent of the surface of the body. The least severe of burns, with regard to both extent of surface and degree of disorganisation are those caused by the action of radiated heat.

Of the many classifications of burns that have been proposed, chiefly by French surgeons, since the beginning of the seventeenth century, the most approved, and clearly the most convenient, are those of Boyer and Dupuytren. The arrangement of Boyer, which has been adopted by most German surgeons, is strictly a pathological one. It divides burns into three degrees, according to the conditions of redness, vesication, and destruction of tissue, these conditions corresponding to the three processes of *hyper-*

æmia, *inflammation*, and *mortification*. In the frequently cited classification of Dupuytren, burns are arranged on a histological basis, in six degrees. The first of these is characterised by erythema or superficial phlogosis of the skin, and the second degree by cutaneous inflammation with elevation of the epidermis and development of vesicles filled by serous fluid; in the third degree, there is destruction of some portion, not the whole, of the thickness of the papillary body; in the fourth degree, disorganisation of the whole of the dermis down to the subcutaneous connective tissue; in the fifth degree, destruction of all the superficial parts, and more or less of the muscular layer; and, in the sixth and last degree, 'carbonization' of the whole thickness of a limb.

Burns will be classified here in three degrees: the first, of congestion; the second, of vesication; the third, of more or less disorganisation of soft parts.

The lesion of the first degree is one of simple scorching. The burnt surface presents an erythematous redness, which disappears readily on digital pressure. The intensity of this redness varies in different cases, and the borders of the rash are ill-defined. The skin is dry and slightly swollen, and the patient suffers from a diffused burning pain which, though sometimes severe, is never so intolerable as in the second and third degrees. In mild cases the redness and pain disappear in the course of a few hours, but in most instances requiring surgical treatment, the pain declines very gradually, the epidermis desquamates, and the surface of the skin remains discoloured for many days. Simple burns of the first degree are most commonly caused by radiated heat, by a very temporary application of the flame of conflagrated gas, or of some inflammable vapour, or by the contact of a solid body or of some fluid moderately heated. This is probably the only form of burn which may exist on the surface of the body unaccompanied by any of the characteristic lesions of one or more of the other degrees, whereas in some severe burns the main lesion, whether it be vesication, or eschar, or deeply reaching slough, is always surrounded by a zone of reddened and hyperæmic skin. In the majority of cases of burn of the first degree the prognosis is very favourable, the injury being a mild one, and needing scarcely any treatment save the application of cold. But following the law that the severity of a burn depends more on the extent than on the depth of soft parts involved, the simple hyperæmic form contributes a very dangerous lesion when spread over a considerable surface. It has been asserted that a burn of the first degree, when it involves two-thirds or more of the surface of the body, will inevitably prove fatal. According to Dupuytren, when the head is the seat of a burn of this, as of any other degree, the irritation may extend to the brain and cause insomnia, delirium, convulsions, and even fatal coma. In a person having a very delicate skin, exposure to the rays of a bright sun, whether transmitted directly or reflected from some extensive white or glistening surface, will often cause intense and painful scorching, which may result in a sharp attack of erysipelatous inflammation.

In a burn of the second degree, the skin is marked by one or, usually, several patches of erythema, each of which is studded with numerous bullæ containing clear and yellow serous fluid. These bullæ vary much in size in different cases and in different parts of an extensive burn. In some instances the vesicles are very small, whilst in the more severe cases an extremity—as the foot or hand—may be covered by one large blister. In this degree there is always pain, which at first is very severe, and, subsequently, as vesicles appear and enlarge, becomes dull and heavy. In the most favourable cases the heat and redness of the surface subside speedily, the vesicles burst and discharge their fluid, and, as the dry and shrivelled epidermis is thrown off, a smooth surface is left which, in the course of a few days, presents the usual appearance of sound skin. If, however, the vesicles be prematurely ruptured and the elevated epidermis be torn away, or if the patient be feeble, the burnt surface may become inflamed, and suppuration and also some superficial sloughing may result. But even in the most prolonged and severe cases, if the burn be one strictly of the second degree, the epidermis will almost always be restored and permanent scars will very rarely be observed. It is often very difficult, however, to determine whether a vesicating burn be a well-marked form of the second degree or a mild form of the third degree; for, as has been pointed out by Billroth, there are many grades between elevation of the horny layer of the epidermis and complete destruction of the cutis.

The characteristic lesions of the second degree are observed most frequently in scalds, and after a very transient application of heated metal. They are, in the primary stage of the burn, more painful than those of any other degree. When much of the surface of the body is involved, especially the front of the chest and abdomen, they are very serious, and in cases of almost complete immersion of the body in some highly heated fluid, are speedily fatal.

In the mildest burns of the third degree, besides the epidermis, a portion also of the thickness of the cutis is destroyed. This degree is characterised by the presence of yellow, grey, or dark-brown sloughs, which in some instances are soft and moist, in others tough and desiccated. These patches are occasionally associated with vesicles containing a turbid and often blood-stained fluid. The disorganised portion of skin is surrounded by a broad zone of erythema, dotted over by small vesicles, such as are met with in the second degree. As was pointed out by Sir Robert Christison, in the more severe burns of this degree, caused during life, the patch of destroyed skin is surrounded by a narrow band of a deep red colour, due to extravasation of blood or very minute capillary injection, which narrow band is separated from the charred part by a stripe of dead-whiteness, and passes at its outer edge by insensible degrees into a diffused blush, involving a considerable extent of the surface around the centre of the burn. It has been proved by experiment that the application of heat to the body, even a few minutes only after death, fails to produce any sign of this reaction. In favourable cases of burn of the third degree the sloughs gradually separate from the living parts, and during or soon after the third week are usually thrown off, leaving the well-known yellowish-white or pale grey surface, thickly studded with bright red points. This surface, after the removal of all dead and foreign material, heals rapidly by the formation of a thin, smooth, and white scar. This scar, though it can never be effaced, is always freely movable over the subjacent parts, and in consequence of its tenuity, and the presence beneath it of healthy cutis, does not tend by retraction to cause any tension or distortion of the surrounding parts.

A more severe burn of the third degree consists in destruction of the epidermis, of the whole thickness of the cutis, and of more or less of the subcutaneous layer of connective tissue. As a rule, however, in burns causing destruction of skin, the surgeon at first is unable to determine the depth to which the disorganisation has been carried, and often finds it difficult to distinguish at first sight a burn of this kind from a severe one of the former kind, or from a relatively mild one of that in which muscle, in addition to skin and connective tissue, has been involved. Again, with regard to prognosis as to the risk of subsequent cicatricial deformity, it is possible that, in the progress of any case of severe burn, excessive inflammatory action and consequent sloughing may cause still deeper destruction of the soft parts, so that in its anatomical conditions a burn of merely the cutis may be converted into one of the whole skin and of subjacent cellular tissue. The importance of the distinction between burns of the third and of the fourth degrees, in Dupuytren's classification, consists mainly in the manner in which the latter heal and in the structure and properties of the resulting cicatrices. In every burn causing disorganisation of the whole cutis, and more or less of the subjacent connective tissue, the open surface heals partly by the formation of dense and very retractile cicatricial tissue, partly by stretching and centripetal displacement of the surrounding skin; and thus it is only in burns which are deep and extensive that the healing is likely to result in the well-known deformity. Great stress has been laid by some authors on much-reduced sensibility as a distinguishing characteristic of burns of the third degree, as compared with those of the two former degrees. The eschars formed by the disorganisation of skin are certainly quite painless, but usually the patient suffers very much at the time the injury is received, and again after the separation of the dead parts and on the exposure of very sensitive granulating surfaces. Besides, as has already been stated, in extensive burns the lesions of two or more degrees are almost always found side by side, the charred surface being surrounded by blisters and a broad zone of hyperæmic and tender skin.

The most frequent causes of burns of the third degree are the action of the flame of burning clothes, and the prolonged application of heated metals and other solid bodies.

In its most severe form the burn has extended below the skin and cellular tissue and involved the muscular and other deep-seated soft parts of the injured region. In these burns, which are much less frequent than those of the preceding forms, a hard, dry, inodorous eschar of a deep brown or a black colour is formed, which on separating exposes fasciæ, muscles, and sometimes large vessels and nerves. In cases of this kind the detachment of the eschar may be followed by profuse bleeding. The deep ulcer formed by the destruction of so great a thickness of the soft parts, heals very slowly and with prolonged and exhausting suppuration.

In considering the general disturbances which may result from the action of concentrated caloric on the surface of the body, it will be found convenient to follow the course of a severe burn through the three stages of *prostration*, *reaction*, and *suppuration*.

The first stage, that of prostration or congestion, lasts from eighteen to twenty-four hours. The most prominent symptom is pain, which varies in its intensity according to the extent of the burnt surface and the degree of the burn. In extensive injuries of the second degree, such as scalds caused by the action of boiling water or steam on a considerable surface of the body, the agony is very great, and, according to Dupuytren, may by itself cause death. The suffering in cases of this kind is often increased through careless removal of the patient's clothes, so that the vesicles are ruptured and the elevated epidermis torn away, leaving large patches of denuded cutis. The general condition, in the first stage of a severe burn, is one either of deep collapse or of extreme restlessness and excitement. The patient often complains of alternate fits of general heat and chilliness. Death often occurs in this stage from shock, the patient either sinking rapidly without the least sign of a rally, or yielding to gradually increasing prostration, after muttering delirium, slight convulsions, and perhaps vomiting, at last succumbs. In children the more common fatal symptoms are convulsions and coma. In the stage of prostration, particularly in cases of very extensive burns of the second or third degree, extreme and obstinate thirst is a frequent symptom. It was pointed out by Nélaton, that many of the subjects of extensive burns complain soon after the injury of a very urgent desire to micturate, although the bladder may be quite empty.

The duration of the second period, which begins with reaction, varies much according to the degree and extent of the burn. In mild injuries of the first and second degrees this period is brief, lasting only for two or three days, but in severe burns of the third degree it does not pass into the final stage until the sloughs have separated and suppuration has become established. Most authors consider two weeks as the average duration of the period of inflammatory reaction. During this period the pain caused by vesicating burns of the second degree gradually diminishes, whilst the subjects of more severe burns in which the cutis has been destroyed, suffer much just before and during the separation of the sloughs. The patient is usually feverish during the early part of this stage, but there is rarely persistent fever or a very high temperature, save when the burn is severe and complicated in its course with local irritation or visceral inflammation. In severe burns involving the surface of the chest, cough is a frequent symptom during this period, and indicates some thoracic complication, as congestion of the lungs, pleurisy, or broncho-pneumonia. The most frequent and troublesome symptoms are vomiting and diarrhœa. The former, when obstinate and associated with the presence of blood in the stools, is suggestive of ulceration of the duodenum. During separation of any large and deep sloughs there may be serious loss of blood, which, in most instances, is due rather to oozing from several small vessels than to free arterial hæmorrhage from one point.

The third period, that of suppuration and exhaustion, lasts from the separation of the sloughs to the healing of the exposed granulating surfaces. The principal symptoms of this period are those due to exhaustion from profuse discharge. The patient, if the burn be wide and deep, may suffer now from hectic fever and marasmus, and be attacked at any time by any of the general or local complications of a large, open and suppurating wound; such, for instance, as erysipelas, cellulitis, sloughing, and diphtheria of the granulating surface, pyæmia and septicæmia, and tetanus. The more special internal complications which may occur during the third period are asthenic inflammation of the lungs and duodenal ulceration. In children convulsions may occur at any time in the course of the suppurating stage of a large burn.

Although the prognosis is much influenced by the degree of a burn, the superficial extent of the lesion is a more important element than its depth. As has already been stated, a very extensive burn of the second, or even of the first degree, is much more serious than a deep burn involving but a small portion of skin. With regard to cicatricial deformity, the more severe burns of the third degree are to be regarded as serious, especially when they are situated on the face, the flexure surface of a limb, the front of the neck, or on the hand. Scalds of the face and mouth are of serious import, as indicating a very probable complication of œdema of the glottis. Burns of the scalp, even when slight, are always liable to be complicated with erysipelas, and extensive burns of the front of the chest very often give rise to inflammation of the lungs or pleura. Burns are more fatal in young children and in old people than in adults, in consequence of the susceptibility to pain and nervous irritation in the former, and of the feeble resistance, in the latter, to the exhausting effects of suppuration during the third stage. Moreover, children are very liable to be attacked by acute inflammation of the lungs or encephalon, whilst old people are seriously affected by any relatively slight complication, by exposure to cold, or any sudden change in the weather.

Of the fatal cases of burn it may be roughly stated that fifty per cent. terminate during the period of shock, thirty per cent. during the period of reaction, and twenty per cent. during the period of suppuration.

There is much variety in the modes of death from burn. Early death, when the injury is severe, is usually due to shock, the patient presenting a general condition similar to that observed after a suddenly produced contusion or laceration of a limb, or a violent injury to the abdomen. In many cases of fatal burn the condition of collapse is doubtless rendered more intense by mental emotion and terror, and also by acute pain, although it may be questioned whether pain *per se* can, as Dupuytren suggested, be the cause of death. In patients who, after having rallied to some extent from the immediate effect of the injury, yet die during the first period, death is usually the result of a condition characterised pathologically by congestion and commencing inflammation of the brain and its membranes, of the lungs and air-passages, and of the abdominal viscera. Dupuytren, who was one of the first to investigate and explain the general conditions which cause death after a burn, showed by post-mortem examinations that in subjects who have perished very soon after a severe burn or scald, and before internal inflammation has had time to develop itself, the brain is much injected with blood and the mucous membranes of the bronchi and intestinal canal are much congested. Moreover, not only are these mucous membranes swollen and studded with large patches of congestion, but the intestines contain effused blood and the bronchi are obstructed by blood-stained mucous fluid. After death, at a later stage—between the third and ninth days—the autopsy usually reveals all the indications of well-marked gastro-enteritis and often of inflammatory changes in the lungs. Dupuytren's statements have since been confirmed by the more extensive pathological investigations of Mr. Erichsen and Mr. Holmes. These surgeons have shown that, after death from burn during the first period, the brain and its membranes are almost always found congested, and the thoracic viscera and the gastro-intestinal mucous membrane very frequently so. After death during the second period, indications of cerebral congestion are still occasionally to be found, but the most frequent and characteristic pathological appearances are those of inflammation, and inflammatory congestion of the lungs and pleuræ, and of more or less congestion of the intestinal tract, frequently associated with ulceration of the duodenum.

Mr. Erichsen, in his observations of fatal burns, found that the brain was affected in thirty-three out of thirty-seven cases, the thoracic viscera in thirty out of forty, and the abdominal viscera in thirty-one out of forty-two cases.

Several views have been proposed to account for this almost constant tendency to visceral congestion and inflammation in cases of severe burn. In 1863, M. Baraduc, a French surgeon, brought forward the purely physical theory that, in consequence of the effusion of serum at the seat of the burn, the blood becomes thickened and plastic, so that it can no longer circulate freely. To this view there are strong and apparent objections. Except in cases of very extensive scalding, very little serum is effused on the surface of the body, and, as is well known, the blood may be deprived of large quantities of fluid, as in rapidly renewed ascites after tapping, without any evident bad result. A viscid condition of the blood after fatal burn has recently been found by Tapperner, of Munich, but as, in each of the four cases which were observed, the injury was very severe, and as much as two-thirds of the surface of the body was involved, death was very probably due rather to shock than to any undetermined result of loss of blood-plasma.

It has been suggested by Billroth that the visceral complications found in the early stages of burn may be due to an accumulation in the blood of nitrogenous compounds, retained as a result of wide destruction of the skin and consequent diminution of the cutaneous respiration. The subject of an extensive burn is, it is thought, placed in a condition somewhat similar to that of an animal completely enveloped in some impermeable material, which, after a time, presents symptoms of intense and fatal blood-poisoning. Well-marked, and even fatal, visceral congestion, however, is frequently observed when but a small extent of surface has been burnt.

Again, in the most extensive burn compatible in the human subject with vitality, there is always much sound skin left, and in burns of the first, and probably in most of those of the second degree, the cutaneous expiration is accelerated rather than obstructed.

Ponfick holds that in severe burns capillary embolism of internal organs is caused through a profound alteration and destruction of the red blood-corpuscles, and it is thought that the congestion of the lungs and the pneumonia so frequently observed in such cases of injury may have some connection with this blood-change. According to Falk, however, the theory that visceral inflammation is due to destruction of red blood-corpuscles in the vessels of the burnt part is not supported by a sufficient number of positive facts. Hoppe-Seyler, on microscopical examination of the blood in cases of severe burn, found the destructive changes in the corpuscles far too slight to give rise to any general disturbance.

It seems very probable that the visceral congestion so invariably associated with severe burn, is caused in great measure, as was argued by Brown-Séquard, by reflex action of the spinal cord; and that the visceral inflammations so frequently observed during the later stages of the treatment are the results either of septic poisoning or, with old and much enfeebled subjects, of prolonged confinement to bed and increased susceptibility to external influences.

There can be but little doubt that ulceration of the duodenum is an occasional result of burn on the surface of the body. Mr. Curling, in 1842, directed attention to twelve instances of this association, and Mr. Holmes found it recorded in 16 out of 125 miscellaneous fatal cases of burn. Simple or non-traumatic ulceration of the duodenum occurs much more frequently in males than in females, and is very rarely observed in patients below the age of puberty. Krauss found, on analysing 42 collected cases of simple ulcer, that the proportion of affected males to females was as 10 to 1, and that 2 per cent. only of the patients were under the age of ten years, and 6 per cent. under the age of twenty. Of 25 cases of intestinal ulceration associated with burn, that have been collected by the writer of this article, in 17, at least, the patients were females. In 6 out of the 25 cases the patients were under the age of five, and in 15 under the age of ten, and in one case only was the age above thirty. In most of these cases the burn had been severe, and had involved a large extent, usually the front of the neck, chest, and abdomen, and one limb or more. In three of these cases death occurred in the first week of the burn, in eight cases in the second week, in six cases in the third week, in a single case in the fourth week, and in two cases in the fifth week. In one case that has been recorded by Mr. Erichsen decided symptoms of intestinal ulceration were observed on the second day after the burn, and death occurred on the sixth day.

The duodenal ulceration is usually situated in the first and ascending portion of this intestine, and near the pylorus. The lesion, which is found most frequently on the front wall of the intestine, consists in one or, as generally happens, two or more small circular ulcers, or one large oval patch of ulceration formed by the junction of two ulcers. The margins of the ulcer are sharply cut, and the ulcerated surface is, as a rule, deeper in the centre than at the periphery, the inner coats of the intestine being destroyed over a greater extent than the serous coat. In acute cases the ulceration has a tendency to involve the whole thickness of the intestinal wall, in some cases extending to the surface of some neighbouring organ, as the pancreas, liver, or gall-bladder; in others, opening freely and directly into the peritoneal cavity, and giving rise to perforative peritonitis. Occasionally the progressive ulceration erodes some large vessel.

Duodenal ulceration is very probably caused, not, as Mr. Curling has suggested, by inflammation and ulceration of one or more of Brünner's glands, but by the action of the acid gastric juice on a patch of mucous membrane in which the circulation of the alkaline blood has been arrested through embolism. In support of this view it has been pointed out that a duodenal ulcer, whether simple or traumatic, has very rarely been observed below the orifice of the common bile-duct.

The diagnosis of duodenal ulcer in cases of burn is very obscure. In some instances it is indicated by epigastric pain, vomiting of dark brown fluid and diarrhœa, with occasional discharge of blood in the stools. In some recorded cases of this lesion, however, all these symptoms were absent, and no indications were observed until after death. If a large vessel has been opened there will be profuse melæna and hæmatemesis, and in cases of perforation symptoms of localised or general peritonitis. Ulcer of the duodenum, though a serious complication, is not universally fatal, as some few instances have been put on record, in which cicatrices of old ulceration were found in the intestine after death from some other or more indirect result of severe burn.

During the third period of a severe burn the patient is exposed to all the risks which attend profuse and exhausting suppuration. In young and feeble subjects the progress towards recovery may be interrupted from time to time by attacks of fever and prostration. The most fatal complication in this final period of suppuration is pleuro-pneumonia. Congestive affections of the abdominal and intracranial viscera are not so frequent in this as in the second period; but in a scrofulous child tubercular disease of the meninges or of the mesenteric glands may be developed during the slow healing of the burnt part. In the third period sudden death occasionally takes place from some obscure cause, which cannot be determined on careful post-mortem examination.

As casual causes of death in the course of the treatment of a severe burn may be mentioned: erysipelas, which is often met with in cases of burn of the scalp; cellulitis, which sometimes occurs in association with an extensive burn of the second degree in the second or third period; pyæmia, not, however, of frequent occurrence; and tetanus.

Treatment.—In the general treatment of a severe burn in its first stage, the main indications are to overcome shock, to relieve pain, to calm restlessness and agitation, and guard against coma. In dealing with intense collapse, the ordinary means for bringing about reaction should be applied. Blankets should be wrapped around the patient, hot-water bottles be placed at the feet and along the sides of the trunk, and brandy with hot water be frequently administered. The intense pain may be best relieved by a full dose of laudanum or liquor opii sedativus, or by a hypodermic injection of morphia. As reaction becomes established, it will be advisable to reduce gradually the supply of alcoholic stimulant, and to give frequently and in small quantities hot beef-tea or soup. If there be much thirst, the patient should take milk mixed with soda-water, weak lemon drink, or barley-water containing a small quantity of dilute sulphuric or phosphoric acid. During the course of the reaction, bromide of potassium may be administered every three or four hours if the patient complains much of pain.

In the second period it is necessary to support the strength of the patient, and to husband his forces, so that he may withstand the exhausting influences of the final period of suppuration. At the same time, however, undue stimulation should be avoided, and a careful watch be maintained for indications of visceral inflammation. The diet should be nourishing, but consist, as far as possible, of fluids—as milk, beef-tea, soup; and where there is a decided tendency to diarrhœa and vomiting, similar precautions in feeding should be taken to those observed in the management of a case of typhoid fever. Symptoms of pulmonary congestion and broncho-pneumonia are best treated, if the patient be not very weak, by liquor ammoniæ citratis and small doses of tartar-emetic; and diarrhœa should be treated by chalk and opium, or small doses of castor-oil and laudanum, or, if very obstinate, by sulphate of zinc and opium.

In the treatment, during the third period of a deep burn, of a large, open, and suppurating wound, it becomes necessary to support the patient's vital powers by giving a free and generous diet with wine and malt liquors; and to overcome, so far as may be convenient, the adverse influences of a long-occupied sick chamber by occasional changes of air and scene.

In exposing the region of a recent burn, extreme care should be taken to avoid rough handling of any destroyed and partially detached portions of skin. This precaution is especially necessary in burns or scalds of the second degree. It is advisable, particularly in cases of burning by caustic agents or through explosion of gunpowder, to remove by gentle syringing with warm water all foreign material that adheres to the injured surface. In the choice of local applications suitable to the different stages of burn, the surgeon has to attend to the following indications:—he should endeavour, in the first place, to cool the burnt surface and to relieve pain, and, after reaction has been established, to moderate local hyperæmia and prevent inflammation by excluding from the seat of injury such external influences as might set up irritation. When eschars have been formed, it becomes necessary, by attention to cleanliness, by the use of antiseptic agents, and by rest of the burnt part, to ward off attacks of cellulitis, and to neutralise any conditions that might be likely to induce septic infection. After the separation of all disorganised tissues, it is requisite to promote speedy cicatrisation, and at the same time to prevent, as far as possible, any subsequent cicatricial deformity.

In the local treatment of burns of the first degree, the main indications are to relieve the smarting pain by applying cold, and to bring about speedy resolution. If the scorched region extend over more or less of the surface of a limb, it should be covered with cold compresses, or the whole extremity be retained for one hour or longer in a cold bath, layers of cotton wool being subsequently applied when the pain and irritation have passed off. In the treatment of a superficial burn of the face, or of a small extent of the surface of the trunk, the immediate application either of iced water, or of lead lotion, or of diluted eau de Cologne, will be found beneficial. In a case of a burn of the first degree, involving one-half or more of the surface of the body, the patient, if an adult and well-nourished, will be much relieved by prolonged immersion in a bath of slightly warmed water; but if very young and collapsed, would be better treated by the local application of some cooling and oily fluid, and, over this, of a thick layer of cotton-wool.

The principal object in dealing with a burn of the second degree is to exclude as far as possible the external air from the seat of injury. If there be any very large vesicles, a few minute punctures should be made in the wall of each at the most dependent parts, so as to allow slow discharge of the contained serous fluid. It is very necessary to avoid laceration of the elevated epidermis, and undue and early exposure of the cutis. The burnt surface should then be covered by some thick dressing, so as to be protected against irritating agents until the complete reproduction of the destroyed epidermis. Mr. Erichsen recommends, in the local treatment of this as of other degrees of burn, the use of the finest wheaten flour, which, when laid on thickly but uniformly and gradually, forms a soft and soothing application to the surface. In cases of extensive vesication, strips of lint or linen which have been dipped in some thick or oily fluid will be found a more convenient and cleanly dressing. Of these fluids the best probably are carron oil (linseed-oil and lime-water in equal parts), carbolic oil (one part of carbolic acid to ten parts of olive oil), a mixture of olive oil and yelk of egg in equal parts. Chalk or zinc ointment, or one of carbonate of lead, spread very thickly on strips of soft lint, will each be found a suitable application to this form of burn. Cotton wadding, absorbent cotton wool and cotton tissue, treated with some antiseptic agent, constitute valuable material for dressings in every degree of burn, and may be applied in thick layers either directly to the injured surface or over any of the above-mentioned lotions or ointments. If cotton wool be applied directly to a vesicated surface, it will be advisable to retain the dressing until the burn has healed or the injured skin has become dry, as the flakes of cotton adhere closely to the loose epidermis, and if removed carelessly and too soon, might tear this away and expose a raw and irritable surface. In burns of this degree seated on the face or one of the limbs, if there be but slight vesication, the application either of castor-oil and collodion (one part to two parts), or of a super-saturated solution of bicarbonate of soda, is to be recommended. In cases of very painful scorching of the whole face, it will be found useful to brush over the reddened surface with some olive-oil or a diluted mixture of glycerine and boracic acid, and then to apply a thick mask of cotton-wool or wadding. In vesicated burns of limited extent, seated on the trunk or one of the extremities, nitrate of silver has often been found very useful when applied either in strong solution (one scruple of the salt to one ounce of water), or as the solid stick.

In treating burns of the third degree, the surgeon should act with the aim of accelerating the separation and removal of the eschars, of controlling putrefaction, and subsequently of promoting the cicatrisation of the open wound. The usual treatment, in cases where a portion of the skin has been destroyed and converted into sloughs, consists in covering the burnt surface with some stimulating dressing, and in applying over this a thick layer of antiseptic wadding.

The following are some of the most useful of the many preparations which have been commended as local stimulants: carron oil, turpentine liniment, carbolic oil, resin-ointment, Kentish's liniment of ceratum resinæ softened with spirit of turpentine, and the compound elemi ointment of the St. George's Hospital Pharmacopœia. The dressing should not be changed except when it is found necessary for the sake of cleanliness. At every exposure of the seat of burn, the sloughing surface should be irrigated and cleansed for some minutes with a tepid solution of carbolic acid (one part to thirty), or a weak iodine lotion, or a solution of chloride of zinc (ten grains to the ounce of water). After removal of the disorganised tissues, the exposed granulating surface is to be treated like any other form of healthy wound or ulcer.

Hebra, who objected to the use of ointments in the treatment of burns of the third degree, advocated the practice of continuous irrigation in cases in which the situation of the burn permitted its employment. He also advocated, as a mode of treating very severe burns, prolonged immersion in a bath of water maintained for many days, and, if necessary, even for months, at a temperature of from 90° to 100° F. This treatment seems to have been hitherto tried but in few cases, and not with any superior results. In order to carry out such a plan, the surgeon would require a special and very complicated apparatus, needing constant attention, and, if used for a very young patient, obviously not free from danger.

In the management of a large granulating surface formed in the more severe burns of the third degree, the surgeon's efforts should be mainly directed to overcoming the effects of cicatricial retraction, and to favouring, as far as can be done, the formation of a thin, smooth, and lax scar. After a deep burn of the face, of the front of the neck, or along the flexure surface of a large joint, more or less deformity must result; but the extent of such deformity, and the nature of the cicatrix may be much influenced for good by careful attention to both local and general treatment during the process of healing. By supporting the strength of the patient and warding off local inflammatory attacks, the granulating surface may be maintained in a healthy condition, so that it will heal steadily and with the formation of a thin yet sound scar.

If the burn involve the flexure of a large joint, as the front of the elbow or the surface of the popliteal region, any muscular contraction which tends to keep up flexion should be steadily resisted, and the affected limb be kept straight on a splint. In the treatment of a granulating wound in front of the neck and of the upper part of the chest, constant endeavour should be made to prevent depression of the chin. In burns about the mouth, external auditory meatus, or any other natural orifice, tents, or solid plugs or tubes with solid walls, should be inserted, with a view of preventing contraction. Much difficulty will be experienced, in deep burns of the hand, in preventing adhesion of two or more fingers. The best means of preventing deformity by reducing hypertrophy and controlling the retractile action of a large scar, are extension of the distorted parts and compression by elastic bandaging. Extension can be readily applied to the lower limb by using strapping and weights, whilst in the upper limb, and probably in some cases of depression of the lower jaw, some good in this respect may be done by ingenious applications of elastic accumulators. Compression may be best effected by firm strapping and the application of a Martin's bandage. In order that any real benefit may be derived from these plans of treatment, they must be carried out with much care and perseverance, and be continued long after the granulating surface has healed.

The eschars formed by very deep burns require similar local treatment to that recommended for other burns of the third degree. An injury of this severity, however, is usually fatal when seated on the trunk, and demands amputation when a portion of a limb is involved.

Primary amputation, the general condition of the patient not forbidding, is indicated when an extremity has been destroyed by a very severe burn. The operation should be performed without delay in any uncomplicated case of hopeless disorganisation of a foot or hand. Amputation has been performed with success even in cases where a portion of the trunk also was severely burnt, and instances have been recorded by Larrey of successful double amputations for burn: one of a thigh and an arm on the same patient, another of a leg and fore-arm, and one even of both thighs. If the extremity be wholly destroyed, the surgeon need not hesitate to take flaps from skin already involved in burns of the second or third degree. The following are the conditions in which it may be found advisable to perform secondary amputation:—Profuse and exhausting discharge from a large granulating surface on a limb, formed on the separation of a deep eschar in a severe burn of the third degree; when much of the integument of a limb has been destroyed, and the retraction of the resulting cicatrix renders the member quite useless, and also interferes with the movements of adjacent sound parts; when a large open surface cannot be healed, or when a large cicatrix has a constant tendency to ulcerate on movement of the affected limb; when a large joint has been opened during the detachment of a deep eschar, and is undergoing disorganisation; in cases of extensive exposure and necrosis of a long bone resulting from burn.

W. Johnson Smith.

BURSÆ, Affections of.—Bursæ may be divided into *subcutaneous* and *deep*. The deep bursæ intervene usually between tendons, muscles, and bones, but sometimes between muscles or tendons. The subcutaneous lie between the skin and exposed bony prominences. Most of the muscular bursæ are hereditary and fairly constant; but the majority of the subcutaneous are developed after birth.

Situations of Bursæ (*Head and Neck*). A large one (sublingual) exists between the genioglossi, back of the symphysis, and the mucous membrane on each side of the frænum, passing back behind the sublingual gland and Wharton's duct to the level of the first or second molar, and constricted in the mid-line by the frænum. *See* Ranula. Occasionally bursæ are seen on the symphysis and angles of jaw: between the back of the hyoid bone and thyro-hyoid muscle, and the thyro-hyoid membrane (thyro-hyoid): rarely on the pomum adami (ante-thyroid).

Upper Limb. — On the subcutaneous surface of the olecranon always; occasionally on the acromion, epicondyles, styloid processes, knuckles and backs of inter-phalangeal joints, bursæ are found. A large, generally loculated sac (sub-deltoid, sub-acromial) always exists between the deltoid and acromion and the head of the humerus. Beneath the tendon of the subscapularis, and along the tendon of the biceps, are protrusions of the synovial sac of the shoulder; fluid may run along the latter from the shoulder, and point beneath the great pectoral tendon. Bursæ are also found between the latissimus and teres major tendons, and between the latter and the bone: between the biceps tendon and the tubercle of the radius: between the triceps and the olecranon above its insertion: and around the tendon of the flexor carpi radialis where it grooves the trapezium.

Around the tendons of the superficial and deep flexors beneath the anterior annular ligament, extending from the level of the wrist-joint to rather below the bases of the metacarpals, is a large bursa divided into two parts—which may communicate—by a mesial septum; the inner surrounds the tendons of the fourth and fifth fingers, the outer those of the second and third fingers and the long thumb-flexor, and communicates with the special sheath of the latter round the flexor tendons in each digit, any one of which *may* join the bursa in front of the wrist. Six sheaths lie beneath the posterior annular ligament, beneath each of which there is a small bursa. Hernial protrusions of the intercarpal synovial membrane on the dorsal aspect are not uncommon.

Lower Limb.—The bursa patellæ consists of two or three distinct or intercommunicating superposed chambers, one at least being subfascial: and there is often another lower down in front of the ligament and tubercle of the tibia. Beneath the gluteus maximus, over the tuber ischii and origin of hamstrings, is a large bursa: another, large and loculated, is over the great trochanter and origin of the vastus externus; small ones exist beneath the tendons of the two smaller glutei, and still smaller in relation with the tendons of the pyriformis and obturator internus. Between the ilio-psoas and hip-joint is a large bursa, which may communicate with the joint: a small one beneath the crureus above the knee, with which it occasionally communicates.

Behind the knee on the inner side, beneath the inner head of the gastrocnemius, and also intervening between this muscle and the semi-membranosus, is an extensive bursa often communicating with the knee-joint. Lower down, between the insertion of the semi-membranosus and the tibia, is a small sac, and on the outer side, between the biceps and external lateral ligament, another, small and inconstant. In front of the upper end of the tibia, beneath the insertion of the ligamentum patellæ is a bursa: and another beneath and between the insertions of the sartorius, gracilis, and semi-tendinosus. Beneath the insertion of the tendo Achillis is a small bursa, and synovial membranes line the flexor sheaths in the toes, the peronei behind the ankle, the three compartments in the anterior annular ligament, and the sheaths in the internal annular ligament.

Injuries.—*Wounds* are recognised by their anatomical position, perhaps the escape of synovia, and the detection of an opened bursa by the eye or probe. Incised and punctured wounds, as a rule, heal easily, but may cause bursitis of all degrees of acuteness; whilst contused wounds, when septic, are often followed by suppuration of the bursa, and cellulitis leading from it. *Contusions*, without breach of surface, are not uncommonly followed by similar results, especially about the elbow; but simple hæmorrhage into the sac is common.

Treatment.—In the case of a wound, render the part aseptic, provide drainage if the wound is large enough to require it; apply some antiseptic dressing, and immobolise the part if practicable. Inflammatory complications must be treated as hereafter advised.

Diseases of Bursæ.—These are all inflammatory—acute or chronic.

ACUTE INFLAMMATION may be serous or purulent.

Causes.—Wounds, contusions, extension of inflammation from surrounding parts; rarely, the extension of a slough of a boil into a superficial sac, and also, rarely, pyæmia. Often none is discoverable. Acute not uncommonly supervenes upon chronic inflammation. The common seats of acute inflammation are—the bursa patellæ (subcutaneous or subfascial, or both), and those over the olecranon, ligamentum patellæ, and tubercle of the tibia; much less commonly, the bursa beneath the insertion of the ligamentum patellæ.

Symptoms.—Redness, heat, swelling with more or less distinct fluctuation, and pain, localised to the situation of a bursa, or, attaining their maximum there, accompanied by more or less fever. In cases of acute suppuration these symptoms are well-marked, redness and œdema may extend some distance around, and the temperature is 101°–3° or even 104° F. If pus in a bursa is not evacuated, it may burst through the thick skin over it; but much more often subcutaneous or subfascial rupture and diffuse cellulitis result, perhaps running on even to sloughing of the subcutaneous tissue. Or the pus may burst into a joint, and, wherever there is danger of this, early relief is specially necessary, as in the case of the bursa beneath the ligamentum patellæ. Lastly, inflammation may spread from a bursa to the bone in which it lies, so that when the abscess is opened carious bone is found at the bottom; or a chronic septic discharge across a bone from a bursa may lead to the same result. This is sometimes found in suppuration of the bursa between the gluteus maximus and the great trochanter,—an affection which may present many of the symptoms of hip-joint disease. *See* HIP-DISEASE. Lymphangitis and lymphadenitis are not uncommon complications.

Treatment.—In the earliest stage, rest upon a splint, and ice. Later on, but still before suppuration has occurred, rest, belladonna and glycerine freely applied, and fomentations changed every two hours. So soon as it is certain that pus is present, it should be let out by incision, a drain inserted, and an antiseptic dressing applied, preferably a large wool one, bandaged with moderate firmness.

If the pus has burst through the skin, and cellulitis is present, the best treatment is to render the drainage free, give rest, and apply fomentations of boracic lint.

If the sac has burst beneath the fascia, and suppuration is extending up and down the limb, free, and possibly numerous, incisions will be required to evacuate the pus, tubes must be inserted, and an antiseptic dressing applied. Frequent boracic fomentations act well. The sinuses are likely to be long in healing.

With regard to the bursa patellæ, an incision into its outer side gives better drainage than a central one, and the scar is less exposed to pressure afterwards.

CHRONIC INFLAMMATION.—Several results are met with. Distension with serous fluid, the wall becoming rather thick and opaque (hygroma or simple dropsy). The fluid is sometimes deeply blood-stained, or may be thick and viscid, and bridle-like bands often project into the interior. Sometimes the wall continues to thicken, the fluid disappearing as it does so; in other cases fluid is never present in quantity, the swelling being due chiefly to thickening of the wall, which may not be uniform. The central cavity may be very small, but is rarely, if ever, obliterated. The thickening is produced either by fibrous tissue of inflammatory origin, or by fibrin, almost laminated and undergoing organisation towards the wall, deposited from blood or coagulable fluid effused into the cavity. Rarely, in old cases, the wall calcifies. Sometimes the interior presents a few or many warty, pedunculated growths; it is thought that these may become detached, and form one variety of loose body found in bursæ. Usually, however, these do not consist of connective tissue, but simply of fibrin, and they have very much the shape and appearance of melon-seeds. They may be dark brown from presence of blood colouring matter, and it is thought that they originate from fibrin derived from blood. It is not known to what they owe their peculiar form. In bursæ actually connected with joints, cartilaginous bodies have been found.

Causes.—Chronic irritation, generally of the nature of friction or contusion.

Seats.—The most common are—the bursa patellæ and others lower down, over the ligament (housemaid's knee); the bursa over the olecranon (student's or miner's bursa); that over the tuber ischii (weaver's bottom); those over the external malleoli (tailor's bursa). These frequently show all the pathological changes described above; whilst deeper bursæ in the neighbourhood of joints are generally affected by simple dropsy only. The bursa between the semi-membranosus and inner head of the gastrocnemius is that most commonly affected.

Symptoms.—A more or less rounded swelling in the situation of a normal bursa, or occurring upon a spot exposed to unusual pressure, varying from the size of a fœtal head downwards—the larger sizes being rare nowadays; enlarging, perhaps rapidly at first, but without acute symptoms, then increasing slowly, if at all; sometimes very lax, again tense, elastic and fluctuating (in simple dropsy); the skin either thickened or, less commonly, stretched so as to be even translucent. With thickening of the wall the swelling becomes firmer, and fluctuation less and less distinct, reaching stony hardness with calcification. Irregular thickening and warty growths are felt if the sac is not so tense as to prevent its walls being pressed into contact. Loose bodies may yield soft crepitus on palpation, and in lax sacs they may be felt and chased from spot to spot; but in tense bursæ they are often first discovered upon opening or aspirating.

Treatment.—When only a few weeks old, counter-irritation with Lin. iodi or blisters, *applied freely*, may cause absorption of the fluid, but it often fails. Aspiration, repeated in three or four days, if necessary, together with fixation upon a splint to which the limb is strapped or bandaged, so as to make firm pressure on the bursa, is more successful. In similar cases, the bursa may be tapped, and injected with a solution of iodine (Tr. iodi and water, equal parts—Billroth), the fluid being allowed to escape after two minutes, and absolute rest for some days being insisted upon. Lastly, strong pressure may be made upon the bursa with a flannel bandage, a splint being placed on the other side of the limb (Volkmann). Reabsorption occurs in two to eight days, according to the size and chronicity of the swelling. In the case of the bursa patellæ sufficient pressure is used to cause œdema of the foot.

When loose bodies are present, they must be completely removed. The best plan is a sufficiently free incision to secure this, and then drainage and an antiseptic dressing. If either local or general thickening of the walls exist in any marked degree, the only treatment certain to cure is excision of the whole bursa. The incision should be placed to one side of the point of chief pressure. Should excision be impossible, removal of a portion of the wall and prolonged drainage may be tried.

The most difficult cases to treat are those of deep bursæ, possibly communicating with a joint, such as are commonly met with in the popliteal space. If the bursa can be emptied into the joint, communication is clear; but, even when this could not be done, inflammation, excited with a view to curing the bursa, has spread to the joint. After the failure of counter-irritation and pressure, which is difficult to apply, it is right to consider whether it is necessary to do more. If it is, cure will be effected almost certainly, and with the least risk to the patient, by antiseptic drainage. This has failed, however, and the sac has been dissected out.

Sometimes a very chronic sinus remains after the bursting or laying open of a bursa. This is best treated by a free incision and the application of the sharp-spoon.

Stanley Boyd.

BUTCHER'S SAW, consists of a narrow steel blade with fine teeth, set in a framework of metal, in which it can be turned so as to work in any direction, and from which it may be readily detached. This saw has been found very useful in excisions and in the removal of small exostoses and of thin sections of bone. The blade, Mr. Butcher states, cannot be locked, cuts more evenly and rapidly than that of the ordinary form of saw, and does not cause splintering. It readily cuts in a curve, and its shallowness and mobility permit of its being applied to the deep surface of a bone, so that it may in sawing be directed towards the surface of the wound, the tibia in excision of the knee being thus divided from behind forwards, and the radius and ulna, in excision of the elbow, from before backwards.

BUTTON-SUTURES.—This term was first applied to an apparatus used by Bozeman in operations for closing urinary vaginal fistulæ. The pared edges of the fistula having been brought together by silver wire, an oval and perforated plate of lead is passed along the free portions of the wires, and is retained over the wound by means of split shots. Another and double form of button-suture is used by Sir Joseph Lister in closing deep and wide wounds after operations on the trunk or limbs. Each suture is composed of two thin perforated discs of lead and some stout silver wire. The lead plates are applied each at some little distance from the edge of the wound, and are connected and approximated by the silver wire being drawn tight enough to allow the edges of the wound to come easily together. The edges of the wound may then be brought together by the ordinary interrupted suture without stretching or irritation. *See* Antiseptic Surgery.

C

CACHEXIA. *See* Malignant Disease.

CADAVERIC WARTS.—A chronic, inflammatory thickening of the integuments, due to the local absorption of decomposing animal matter.

This affection is not infrequent on the hands of those who have to make many post-mortem examinations. Sometimes it begins with a small crack or pustule, but more often, without any evident breach of the surface, the skin at some point of the knuckles is observed to become thick and rough. The thickening spreads, and the skin assumes a livid, purplish colour, and, after a time, there is a deposition of pigment, which gives the elevation a brownish appearance. The epidermis may become cracked and scaly, and a condition is then produced which resembles ichthyosis. In many cases the thickening develops into a low warty growth, half an inch or more in diameter, and elevated nearly an eighth of an inch above the adjacent skin. In other cases the papillary structures do not appear to be so much affected, and the disease has more of the aspect of a chronic eczema. Several fingers are often simultaneously affected in both hands, usually on the knuckles of the metacarpo-phalangeal, but sometimes upon those of the first phalangeal joints. According to Dr. Wilks, who first described it, those who are subject to this affection may continue their avocation with impunity as regards putrid absorption or inflammation of the lymphatics, for, as far as he has seen, neither these nor any constitutional symptoms result. The low warty growths may bear some resemblance to an early stage of epithelioma, but their multiple occurrence, the absence of glandular implication, and the employment of the patient, will generally suffice for their recognition.

The disease may persist for many years after the irritation which has caused it has ceased. It is advisable to keep the hands from contact with decomposing animal fluids, by desisting from pathological work, or by adopting the protection of india-rubber gloves. In the earlier stage of the disease it will be sufficient to apply the strong tincture of iodine. If this fails, the surface should be cauterised with nitric acid, or the liquor hydrargyri nitratis. When the swellings have a distinctly warty character, it may be necessary to resort to excision.

N. Davies-Colley.

CÆSAREAN SECTION is the operation for the removal of the child and placenta from the uterus at term, by abdominal and uterine section. It is performed when delivery is impossible by the natural method, even if the child be sacrificed and embryulcio performed.

Some difference of opinion exists as to the indications for the operation, and especially between British and Continental authorities, but a discussion of this subject will be found in any of the best obstetrical works, and is beyond our limits here. The necessity for the operation may arise either from pelvic deformity, (rachitis and mollities ossium are the diseases which most often cause such pelvic deformity), or from the presence of a tumour fixed in the pelvis, most often a fibro-myoma, or from cancer of uterus, cervix, or rectum, or exostosis of the sacrum. The late Sir James Simpson taught that when the brim of the pelvis is below 1½ or 1¾ inches in the conjugate by three inches in the transverse diameter, or when the cavity or outlet is much contracted, Cæsarean section should be performed. The operation should be performed before the mother's strength is exhausted. It is well to wait till labour be sufficiently advanced for the os to be well dilated, on account of the drainage of the uterus. It is an alternative to craniotomy, cranioclasm, and cephalotripsy. In some cases it may be performed even though the mother be dead, in order to save the life of the child.

Operation.—The bladder having been emptied by the catheter, the vagina and vulva carefully cleansed with an antiseptic solution, and the rectum cleared by enema, the patient should be laid on her back on a convenient table, and with exactly the same preparations as for ovariotomy. *See* Ovariotomy. An incision should be made in the linea alba about five inches long, and, when the peritoneum is reached, great care should be exercised in dividing it, for fear of wounding the highly vascular pregnant uterus. When all bleeding from the parietal incision has ceased, and the uterus has been fully exposed, the placental site should if possible be determined in order to avoid it in incising the uterus. A longitudinal incision from four to five inches long should then be made in the uterine wall (a small opening with the knife rapidly extended with scissors); the hand introduced and the child extracted, head first, as quickly as possible, and handed to an assistant, who ties the umbilical cord. The placenta should also be extracted, being peeled from the uterine wall if necessary; then the index finger should be pushed through the cervical canal into the vagina, to insure this canal being left patent, and it may be well to pass through it a soft rubber drainage-tube, with large side holes, just long enough to extend from above the internal os into the vagina; the hand should then be quickly withdrawn, and the uterus grasped till it contracts firmly.

The very greatest care should be taken, during the incision of the uterus and the extraction of the child and placenta, to prevent escape of blood or liquor amnii into the peritoneal cavity, and this may be most safely done by placing large, soft, flat, carbolised sponges all round between the parietal peritoneum and the uterus, and causing an assistant to press the parietes firmly upon these sponges during the extraction. The uterus should be grasped to cause it to contract, and when it has contracted firmly, a row of fine carbolised silk sutures should be inserted through the whole thickness of its wall, by means of a fine curved needle. Each suture should include about a quarter of an inch of the peritoneal edge, and slant through the uterine wall, merely catching the mucous membrane and not going right through it into the cavity. These interrupted sutures should be about a quarter of an inch apart in the contracted wall, and after they have been securely tied and cut short, a fine continuous carbolised silk suture should be run along over them through the peritoneal coat only, the needle being made to transfix the peritoneum between these interrupted sutures.

The peritoneum should then be carefully sponged out, and the abdominal incision closed as in ovariotomy, a small gauze dressing being applied over the wound, and outside this a firm folded towel as a pad, and over this the usual adhesive straps; then outside the straps a large folded mass of cotton wool, over which a lined flannel bandage is pinned; this keeps up a firm elastic pressure on the uterus. The vagina should be syringed with warm 1 to 60 carbolic lotion, and lightly packed with iodoform gauze, which should be changed every twelve hours under the spray for the first few days. A subcutaneous injection of ergotin, and the early application of the child to the breast (if the mother be not too much exhausted), are advisable, as likely to keep the uterus firmly contracted.

In the event of the child being already dead and putrid, still greater care will be necessary to avoid fouling the wound, which should be completely covered all round the projecting uterus with napkins wrung out of warm 1 to 40 carbolic lotion. The uterine cavity should be well sponged out also with a strong solution of iodine, and a Keith's glass tube, with rubber sheet and carbolised sponges, should be used for draining the pelvis. This latter precaution may be advisable, not only in cases in which the child is putrid, but in any case in which escape of uterine contents into the peritoneal cavity has occurred during the operation.

The treatment of the patient after operation should be similar to that advised after ovariotomy. When syringing out the vagina and packing it after the operation, the rubber tube should be pierced by a safety pin placed across the os so as to prevent its being drawn into the cavity, and the tube may be removed altogether in about forty-eight hours when the peritoneal wound in the uterus is sealed.

J. Knowsley Thornton.

CALCIFICATION is an indication of diminished nutritive activity. This is true both as regards health and disease. Physiologically the deposition of lime-salts is the last of the series of changes concerned in the formation of bone where it is purposive, inasmuch as it gives the required durability, but at the same time it marks the loss of formative power of the osseous corpuscles. Pathologically it may occur as a primary change in previously healthy tissues, but more frequently it is consecutive to some other form of failure in nutrition—inflammatory or degenerative.

It is very widely distributed in the *vascular system*; thus it is found in the *heart*, affecting the valves and the walls of the coronary arteries; and large stony plates are occasionally met with in the pericardium.

The *arteries* are peculiarly prone to petrifaction. The muscular fibre-cells of the middle coat of the small and medium-sized vessels are often converted into calcareous rings, and the neoplasia of chronic endarteritis of the large arteries is very liable to infiltration with lime-salts.

The *veins* are subject to the change both as regards their walls and contents. In them, as in the smaller arteries, the tendency is for the middle coat to be first invaded. The rigidity of the vessels thus occasioned is a secondary cause of thrombosis. *Phleboliths* are mostly found where there has been passive venous congestion —a condition favourable both to chronic plastic phlebitis and coagulation of blood. There is some doubt how far these calculi are petrified clots, or inflammatory buddings of the intima that have undergone calcification. They are most common in the prostatic venous plexus.

Disorderly calcification is one of the chief anatomical features of *rickets*, in which disease the epiphysial cartilage-cells are imprisoned, and their natural segmentation checked by the calcareous deposit in the secondary capsules.

Taken as a whole, calcification is most common in tissues that have succumbed to *chronic inflammation*. Examples of this in the vascular system have already been cited. The lesion is not rare in the membranes of the brain and cord; thus one meets with broad plates in the cranial dura mater, especially in old people. The author has observed patches of calcification as a sequel of traumatic, cerebral, and spinal meningitis. A like condition may be acquired by articular and synovial sheaths which have been chronically inflamed. But whilst calcification occurs in these cases of fibroid induration, it is much more likely to happen in connection with caseation of inflammatory products; thus it is met with in 'obsolescent tubercle' of the lungs and lymphatic glands. The inspissated pus of cold abscesses may contain such an excess of lime-salts as to simulate mortar of various degrees of consistence and grittiness. It is an interesting fact that passive congestion conduces alike to absorption of earthy salts from normal bone, and to their re-deposition in the contents of consecutive abscesses, as exemplified by the history of scrofulous caries.

Calcification sometimes affects the pyramidal blocks of degenerating tissue, the result of aseptic arterial embolism. There is scarcely an instance of fatty metamorphosis where calcareous infiltration may not be found in greater or less extent. It is a possible sequel to such widely different processes as 'ossification' of the choroid coat of the eyeball, extra-uterine gestation, and retrogression of the thymus gland. The interstitial tissue of the internal organs—the lungs and kidneys, e.g.—may be the seat of diffuse calcareous deposit secondary to absorption of the bone-salts from the osseous system generally.

Of the *new-formations*, those characterised by slowness of growth and other signs of benignancy are, by preference, selected by the process of calcification. The enchondromata are peculiarly prone to petrifaction with or without true ossification. In them, as in other tumours, the cells are invaded subsequently to the matrix. The *fibromata* may undergo interstitial or, much more rarely, capsular calcification. *Uterine fibroids* are now and again observed to be converted into stony masses.

The *psammomata* which, on anatomical grounds, are by Cornil and Ranvier classed with the sarcomata, are typical of calcified neoplasiæ. They are small, concentrically laminated, globular concretions found in the choroid plexuses and other parts of the pia mater. The deposit affects chiefly the walls of the capillaries.

Cysts are sometimes converted into a kind of shell or carapace. This is notably the case in hydatid and atheromatous or sebaceous tumours. Calcification may occur as a secondary change in *hypertrophy of the thyroid gland*, where it is usually seen in the form of cretaceous nodules.

Fragments of a calcified growth appear opaque when viewed by transmitted light. The constituent cells may be completely hidden, but their outline becomes apparent on the addition of a dilute mineral acid. The chinks or clefts present in these tumours must not be mistaken for the lacunæ of true bone. They do not contain corpuscular elements. Calcification is the essential process in the formation of salivary and many urinary calculi. In the majority of cases of calcareous infiltration the salts consist of calcic carbonate and tribasic phosphate.

AUGUSTUS J. PEPPER.

CALCULUS, Prostatic. *See* PROSTATE, Diseases of the.

CALCULUS, Renal. *See* NEPHROLITHIASIS.

CALCULUS, Urethral. *See* STONE IN THE URETHRA.

CALCULUS, Urinary.—Urinary concretions assume different forms, and exhibit great varieties both in their general appearance and chemical constitution.

The most common forms are simple calculi of uric acid or of oxalate of lime, and the compound calculi of phosphate of lime, with ammonio-magnesian phosphate, or of either of the above elements with mixed phosphates. Less frequently observed calculi are those of urate of ammonia, of triple phosphate, and of cystine. The most rare forms of urinary calculi are those composed of xanthic oxide, pure phosphate of lime, and of carbonate of lime. In this country uric acid calculi make up about 25 per cent. of the whole number, the fusible or mixed phosphatic calculi about 10 per cent., and the oxalate of lime calculi about 15 per cent. The relative proportions of the forms of calculi would seem, according to the investigations of Indian collections by Dr. H. V. Carter, to vary in different countries.

The *uric acid calculus* has a smooth or slightly nodulated surface, is of a reddish-brown, yellow or fawn colour, is more or less ovoid in shape, and hard and compact. It is met with in greatly varying sizes, some stones weighing but a few grains, and others from six to eight ounces. The central portions are for the most part darker than the peripheral. On the application of heat it is found to be combustible, leaving very little residue. It is soluble in nitric acid with effervescence; and, on evaporation, with the addition of a few drops of ammonia, presents a blood-red hue. It is also soluble in a dilute solution of potash, and of carbonate of potash, but is insoluble in water, alcohol, and dilute hydrochloric acid.

The *oxalate of lime* or *mulberry calculus* is mostly darkish brown in colour, varying from this to a dark green, yellowish-brown, bright yellow or white. It usually presents sharp angular projections, or has a very rough and tuberculated surface. It is spherical in shape, is very hard and compact, and, on section, exhibits a laminated and finely granular texture. The oxalate of lime calculus, in its ordinary form, is usually single, but there is a variety of this concretion called 'the hemp-seed calculus,' consisting of very small, pale, and smooth bodies, which are sometimes found in large numbers in the kidney.

The white variety of mulberry calculus is crystalline, and consists of nearly pure oxalate of lime. This form is very rare. Oxalate of lime calculi are found to be soluble in hydrochloric acid, but insoluble in acetic acid and in water. They burn with a white glow under the blow-pipe, and the moistened residue gives an alkaline reaction.

The *ammonio-magnesian* or *triple phosphate calculus* is rare, and very few specimens are to be found, even in the largest collections. The calculus is usually large, and has been found mostly in men of advanced life. It is more or less oval in shape, white in colour, with a beautifully crystalline surface; on section it is found to be indistinctly lamellated. In some specimens the texture is compact, in others soft and friable.

The *ammonio-magnesian phosphate of lime*, or *fusible calculus* is of frequent occurrence, and often attains a considerable size; the largest specimens in collections of calculi being mostly of this variety. This calculus is of a white colour, usually globular or ovoid, but sometimes very irregular in shape, light as compared with other forms of stone, and brittle or quite soft. It is this material that forms the well-known incrustation on foreign bodies introduced into the bladder.

The *cystic oxide* or *cystine calculus* is small, and rounded or oval in shape, with a smooth or slightly tuberculated surface, and has a yellowish-white or pale green colour. It has a glistening appearance, and on section gives off a peculiar garlic-like odour. It is combustible and burns with a bluish flame and characteristic odour, and is soluble in nitric and other mineral acids. It contains above 25 per cent. of sulphur. This variety of calculus is formed in the kidney, and has a tendency to recur in the same patient. There seems to be some hereditary predisposition to its formation, as, according to Poland, out of twenty-two collected cases, ten occurred in four families.

The *xanthic oxide* is probably the rarest form of urinary calculus, four instances only having been recorded. The smallest of these weighed eight grains, and the largest 339 grains. It presents a smooth surface, and a cinnamon-brown or reddish-yellow colour, and is made up of concentric wavy laminæ. It leaves very little, if any, residue on combustion, and is soluble in the mineral acids.

The *phosphate of lime calculus* is very rare in the pure form. It is hard and compactly laminated, and has a smooth, porcellanous surface. When submitted to the blow-pipe, it whitens but does not fuse, and is soluble in hydrochloric acid without effervescence. Phosphate of lime, though very seldom met with as a true renal or vesical calculus, forms the bulk of the so-called 'bone-earth' calculi, or the soft amorphous masses of deposit so frequently found in cases of diseased bladder with decomposed urine.

Carbonate of lime enters into the composition of some few forms of prostatic concretion, and is occasionally met with in animals, but very rarely, if ever, forms a true urinary calculus in the human subject.

A mixed or *alternating calculus* is one made up of different layers of any of the foregoing varieties. This mixed composition is the result of changes in the condition of the urine at different stages of the growth of the stone. Hence a change of residence, even from one part to another of the same country, or a material alteration in the habits of life of the patient, may be promoting causes. The most frequent combinations are: a nucleus of uric acid with a body of pure uric acid or of urates and a crust of phosphates; a nucleus and body of oxalate of lime, and a crust of irregular thickness, composed partly of phosphates, partly of uric acid; a nucleus of uric acid or of urate of ammonia, surrounded by alternating layers of uric acid and mixed phosphates.

The so-called fibrinous, sanguineous, and uro-stealith calculi being simply concretions of organic matter, and not crystalline formations, need not be considered here.

The development and growth of each of the ordinary forms of urinary calculus are associated with a somewhat characteristic condition of the urine. In the uric acid diathesis this secretion is scanty, highly-coloured, and deposits on cooling distinct coloured crystals of uric acid, forming the well-known 'gravel' or 'cayenne-pepper' deposit. A reddish-yellow 'brick-dust' sediment—probably urate of ammonia—which disappears on the application of heat, or on pouring water into the vessel containing the urine, is common in health and must not be confounded with the uric acid deposit. In cases of oxalate of lime calculus, the urine is pale and abundant without sediment, and generally contains traces of blood, and crystals of oxalate of lime may sometimes be detected on microscopic examination. In association with phosphatic calculi, the urine is pale and copious. It soon decomposes, and then becomes very offensive. It is very often alkaline, and contains much mucous deposit. *See* Stone in the Male Bladder. T. W. Crosse.

CALCULUS, Vesical. *See* Stone in the Male Bladder; Stone in the Female Bladder.

CALLISEN'S OPERATION, *See* Colotomy.

CALLUS. *See* Fractures.

CALOMEL VAPOUR-BATH. — In the opinion of Mr. Henry Lee, who has long advocated calomel-fumigation in the treatment of constitutional syphilis, the most convenient apparatus to use in giving a calomel vapour-bath is one that sublimes the calomel and boils the water at the same time. Mr. Lee's apparatus consists of a metal receptacle with perforated walls, in which the lamp is placed, and immediately over the wick is a small circular plate, on which from ten to twenty grains of calomel are placed, and around this plate is a depression, into which is poured boiling water. The lamp having been lighted and the apparatus placed on the ground, the patient, covered from head to foot by a thick cloak of some impermeable material, sits over it on a cane-bottomed chair, and remains there for about a quarter of an hour, surrounded by a mixture of aqueous vapour and sublimed calomel. The surface of the body, during the bath, becomes covered by a black deposit of calomel, which should be disturbed as little as possible for some hours.

CANALISATION OF CLOT.—The process by which restitution of the lumen of a vessel is effected after occlusion by organisation of a thrombus.

This result is an outcome of the ordinary cicatricial changes occurring subsequently to the vascularisation of a thrombus. The channel may be a single one, as is occasionally seen after ligature in continuity of an artery, the vessel not being completely divided. The channel in this case is considerably smaller than the original one. In other cases the clot may become permeated by numerous channels, a condition sometimes noticed after thrombosis of the larger veins, such as the iliacs. In either case the permanent channel is due to the enlargement of one or more of the new blood-vessels formed during vascularisation of the clot. This enlargement is effected by the shrinking of the young connective tissue forming the organised thrombus, aided, in some degree perhaps, by the intravascular pressure. G. H. Makins.

CANALISATION OF THE PROSTATE (Perforation of Prostate. Forcible Catheterism).—This operation was formerly practised in prostatic retention of urine, when the catheter could not be passed. A No. 10 stout silver catheter with a conical point was passed down to the prostatic obstruction, kept steadily in the middle line, and the shaft forcibly depressed until the point penetrated the base of the middle lobe and entered the bladder. Sometimes the catheter was made with a terminal orifice, through which a sharp-pointed stylet could be protruded, to prepare a way for the catheter. When the bladder was reached, the catheter was retained for a day or two, and then immediately replaced by another, and so on, until the surgeon considered that the false passage had become a permanent canal. Owing to the introduction of soft catheters of all shapes, the operation belongs entirely to the past. Patients so treated were exposed to grave risks. It can only be justifiable now, when the case is urgent and the surgeon beyond reach of soft catheters, or instruments for suprapubic tapping or aspiration.

G. Buckston Browne.

CANCER is a term used differently by different authorities. By some it is employed as equivalent to carcinoma; by others as a generic term for any truly malignant growth. *See* Carcinoma; Sarcoma; Malignant Tumours.

CANCRUM ORIS. *Synon.*: Noma of the mouth, Gangrenous stomatitis.—A rare form of gangrene of the lips and cheeks in weakly children, often after an acute fever: it is painless, rapid, and intractable, and causes death by blood-poisoning, or bronchitis, or pneumonia.

Although there are many intermediate forms of disease between cancrum oris and ulcerative stomatitis, yet a marked case of cancrum oris cannot be mistaken. The cheek is hard, hot, glossy, swollen, œdematous, invaded by a spreading patch of gangrene which is black edged with red; the whole thickness of the cheek is killed and putrid; the bones are bare, grey, and dead; the teeth come out. The disease may begin in the substance of the cheek, without visible disease of the mucous membrane; but usually the mucous membrane is affected early or primarily. The disease is at first insidious and often neglected, attacking as it does those children who are always weakly and ill-fed. Even after it has gone on to perforation, there is strange freedom from pain, strange indifference to the hole in the cheek, save for the difficulty in taking food; the child will even finger it inquisitively, and cover it with the hand while swallowing. Later, the child becomes exhausted and stupefied, or delirious and feebly restless, and dies either suddenly, as if from sheer exhaustion, or poisoned by the products of putrefaction, or from bronchitis or pneumonia due to inhalation of these products.

In one case at least, both cheeks have been attacked. It is almost confined to children of a few years old: in two cases of adults it is noted that there seemed to be more suffering than children feel.

Cancrum oris is something more than stomatitis, but it often begins in stomatitis, and has much in common with it. All forms of stomatitis, except the special ulcerations of syphilis and tubercular disease, are due in part to ill-health and severe depression; the mucous membranes being as much a register of the general health as the skin. The same causes predispose the child to cancrum oris; it is a disease of children depressed by all the evils of the worst poverty; it follows measles, typhoid, scarlet fever, ague, or some such cause. Bad drainage, the frequent cause of sore-throat and ulcerative stomatitis, probably also is at work in cancrum oris. It may follow the abuse of mercury (West), or the prolonged suppuration of a bad burn.

As regards successful treatment it is almost hopeless: the recorded deaths are 13 out of 18 (Hinder), 8 out of 10 (West), 20 out of 21 (Rilliet and Barthez), all out of 36 (Taupin of Paris). With more cheerful statistics comes a doubt whether those cases that recovered were all cases of real cancrum oris.

These three points, then, mark it off from ulcerative stomatitis: 1. Its destruction of the whole thickness of the cheek. 2. Its almost certain fatality. 3. Its advance, quite unchecked by chlorate of potash. Still, between it and ulcerative stomatitis there are intermediate forms, and there is no evidence that the difference is more than one of degree.

Pathology.—There are two views: one, that it is only a local expression of the general low vitality of the child—a local death preceding death itself, like the loss of hair or nails after a fever, or the sloughing of the penis after typhus (Holmes); the other, that it is due to a special poison. As regards the first view, the difficulty is to see why the cheek should be thus singled out. In other forms of gangrene from malnutrition, as in diabetes, and after loss of blood and exhaustion, the gangrene is of the extremities. The cheek is so richly supplied with blood, so quick to heal, that it would hardly be the first part of the body to give way under a general depression, but rather the last.

As regards the other view, it may be that in cancrum oris some other agent is added to those already at work upon the health of the child. This fresh factor is not the lingering effects of a fever through which the child may have recently passed, for cases of cancrum oris occur without this. Nor is it only the evils of poverty; for in that case cancrum oris would be much more common. Rather it is probable that this added something is imported from without; that it is a fresh disease, a poison like the poison of syphilitic phagedæna and hospital gangrene, perhaps indeed the very same as these. These diseases are contagious; all they require is a proper soil and cultivation. And that cancrum oris has not yet been proved to be contagious, or to spread an epidemic of phagedæna, is due to its rarity, and to the prompt treatment given to it; and also, as Hutchinson suggests, to the fact that, as its process is very rapid and almost wholly one of gangrene, it destroys its own living pus-cells and nuclei, and thus limits its own power of spreading by contagion.

Thus, as phagedæna is a contagious disease, invading syphilitic sores—primary, secondary, and tertiary—commonly in young, fair, thin-skinned patients, whose secondaries are of an ulcerative type; attacking the patient, in many cases, more than once; laying hold on chancres of the glans more often than those of the foreskin, and on foul ones more often than clean ones; so cancrum oris also is phagedæna, invading the weakened or abraded or already ulcerated mucous membrane of the mouth in half-starved, fever-wasted children, or possibly first entering the circulation, and then finding in the cheek a suitable soil for development.

As yet, no organism has been isolated from cancrum oris, nor has the disease been inoculated. Dr. Sansom, examining the blood, urine, fæces, and discharge from a case on the third day, found in all of them small highly refractile bodies, like colourless crystals, about one-twentieth part of the size of a red corpuscle; their movement was spontaneous, rectilinear, influenced by chemical agents. They formed zooglœa-like masses, and became fewer with hæmorrhage and fall of temperature. The blood, injected into mice, produced septicæmia and death, with multiplication of the refractile bodies; the discharge, injected into a cat's abdominal cavity, produced fatal peritonitis, but no refractile bodies were found in the blood. (*Med.-Chir. Trans.* lvi.) In a second case of cancrum oris, Dr. Sansom did not find these refractile bodies. In the first case, he found the white cells irregular, diffluent, granular, and unduly numerous, the red cells unduly small. The nature and action of these refractile bodies remains uncertain; but the observation is of great value.

Lastly, it may be observed that Mr. Hutchinson's teaching as to cancrum oris is more in favour of this view than it was. In 1856 he says it differs from ulcerative stomatitis probably in degree only—that it is only an intense and rapid form of it; though he does not deny that possibly mere ulcerative stomatitis may be connected with a specific poison. In 1877 he classes together cancrum oris and noma as forms of sloughing phagedæna, and thus as allied to or identical with the contagious diseases called hospital gangrene and syphilitic phagedæna.

The *treatment* of cancrum oris is very discouraging. Every case of ulceration of the mouth of a child must be carefully watched. If it does not improve under large doses of chlorate of potash, with wine, tonics, good food and air, and local treatment, chloroform must be given, the cheek must be exposed, rubbed, and dried, and then carefully and slowly soaked with the strongest nitric acid. A saturated solution of bicarbonate of soda or potash should be at hand, to guard the action of the acid. The application may be necessary more than once.

If the child is not seen till the cheek is red, hard, and swollen, the acid must be applied at once, and poultices externally. If the black patch of gangrene has already appeared, it is useless to cauterise the inside of the cheek; it is best at once to punch out the rotten slough, to scrape and dry the hole all round as much as possible without making it bleed, removing as much dead tissue as will come away, and then to apply the acid freely. But in such a case, the sodden putrid tissues are apt to suck up the acid, and prevent its reaching the ever-advancing edge of the disease, and repeated applications only make bad worse. Since this is so, might it not be better, when once the whole thickness of the cheek has sloughed, to excise the whole slough with the knife? If the knife were carried clear round the disease, the first suspicious spot in the granulating wound would be immediately seen, and if only the angle of the lips were saved, the deformity might not after all be very bad. The use of the actual cautery, as Trousseau recommends it in advanced cases, 'by repeated application, including the whole thickness of the cheek, the gums, and the exposed bone,' is at least as severe. Both acid and cautery leave an eschar, which hides the spread of the disease and hinders their own further efficacy. It is possible that, in some cases, free excision might save life, where they would not. STEPHEN PAGET.

CAPELLINE BANDAGE. *See* BANDAGES.

CANQUOIN'S PASTE. *See* CAUSTICS.

CARBOLIC ACID. *See* ANTISEPTIC SURGERY.

CARBUNCLE (*Syn.*: Anthrax) is a specific local inflammation of the superficial connective tissue, affecting to some extent the skin, and characterised by numerous openings which lead to a subcutaneous slough.

Its *Causes* are similar to those which produce boils. It is, however, usually found in those who are past middle life. Men are more subject to the disease than women. It attacks those who are debilitated by too good or too poor living. Thus, the plethoric and gouty suffer from it as well as convalescents from zymotic disease, and women who have been weakened by prolonged lactation. There is often a history of antecedent dyspepsia. The diabetic are especially liable to it, and according to Billroth, it is also frequent among uræmic patients. It has been known to follow the eating of diseased meat. The locality of the affection is often determined, in those who are already predisposed to it, by some friction or pressure. Hence it is apt to occur on the nape of the neck or on the nates.

Symptoms and Course.—Beginning as a red, hard, and very tender swelling of the skin, it rapidly spreads by the margins until a circumscribed, somewhat flattened elevation is formed, varying from an inch to six inches or more in diameter, and elevated one quarter to half an inch above the surrounding integuments. The colour which is at first red, soon becomes dusky, and even livid. In less than a week vesicles form over the middle of the swelling. These burst and leave a number of small openings, from which a thin sanious discharge exudes. As the openings widen, a greyish-yellow slough becomes visible. In the course of a few days they coalesce, and form a ragged aperture from which pus freely escapes, accompanied by large masses of slough. Soon a granulating cavity is left with undermined edges. By secondary union, and by the growth of the granulations, this is converted into a healing ulcer, which rapidly contracts and skins over. A puckered and somewhat discoloured scar remains.

The disease is usually single. Sometimes it shows a tendency to creep at the margins while the sloughs are being discharged at the centre. The duration may vary from two or three weeks to several months. It is apt to assume a chronic form in weakly patients, or where the thick skin retards the formation of the apertures by which the slough is discharged.

There is often considerable constitutional disturbance preceding the outbreak, such as chilliness, or even rigors, feverishness, irritability, and dyspepsia. While the swelling is growing, the fever may be of the sthenic type, and the pain is of an intense, throbbing character. In the aged, and in those in whom the affection has lasted two or three weeks, great prostration, with a typhoïd condition, may supervene, and there is danger that death may occur from exhaustion or pyæmia. When the scalp is affected head-symptoms may ensue, and the patient may sink from coma preceded by delirium.

Pathology.—A carbuncle may be looked upon as a collection of boils, and it differs from them chiefly in the large destruction of skin by which it is attended. It is probable that the disease attacks first the sebaceous glands of the hair-follicles. Its chief site is in the connective tissue around them and immediately beneath the skin. The slough is composed of connective tissue infiltrated with fibrinous exudation and leucocytes. It is full of oil-globules from the disintegration of these structures, and its evascular condition is shown by the dirty yellowish-grey surface exposed when free incisions are used. The muscles are rarely attacked. It may sometimes give rise to plugging of the veins, and in this way lead to pyæmia.

Diagnosis.—Carbuncle may be distinguished from a boil by its size, by the numerous openings, by the livid colour, and by the fact that it is rarely multiple. From other phlegmonous inflammations it may be known by its circumscribed character, its brawny hardness, and the sieve-like perforations of the central covering. The peculiar character of the eschar will usually suffice for the recognition of MALIGNANT PUSTULE.

The *Treatment* by *local* means may be classed under four heads—

(1) Two free incisions may be made at right angles to each other through the slough into the living structures beneath and beyond. This method relieves pain and facilitates the discharge of the slough, but it is attended with so much bleeding that it should only be used in the young and robust.

(2) The same advantages can generally be obtained by the use of potassa fusa, small pieces of which should be thrust

through the openings into the slough beneath. If the openings are slow to form, or not large enough, small incisions may be made before inserting the caustic. By this plan the gangrenous mass is speedily and with little pain converted into a blackish gelatinous material, which is easily discharged. Care, however, should be taken to prevent the caustic from injuring the adjacent skin by the use of rags dipped in vinegar.

(3) Pressure by means of strapping carried over the swelling to the sound parts around has been strongly advocated. An opening should be left for the escape of the discharge.

(4) An expectant treatment with applications of linseed poultice or resin ointment.

After the employment of methods (1) and (2), a mixture of carbolic acid and olive oil (1 to 40), or boracic acid ointment, forms a good application. The pain may be allayed by the addition of the extracts of opium or belladonna to poultices or water-dressings. Plenty of nutritious food should be given, accompanied by alcoholic stimulants when the patient is in a debilitated condition. Dilute sulphuric acid with quinine and iron is beneficial.

FACIAL CARBUNCLE. — Ordinary carbuncles occur upon the face, which do not differ in their course from those situated in other regions. Occasionally, however, we see a very acute and fatal affection, which has some resemblance to the ordinary form, and has been described as *Malignant facial carbuncle.* This usually follows the accidental inoculation of some animal poison. Thus, the writer has seen it attack the lip of a woman who had been scratched by a child with severe scarlet fever, and the lip of a man who, after circumcision, had probably conveyed to it some matter from the sloughy wound which followed the operation.

It is generally seen at an earlier period of life than ordinary carbuncle,—e.g. between the ages of twenty and thirty. Beginning as an itching pimple, usually upon the upper or lower lip, the swelling rapidly affects the whole lip, which is soon four or five times the natural size. It is brawny, livid, and very painful. Numerous pustules or vesicles form, especially upon the red surface of the lip. The inflammation extends upwards towards the eye, or downwards towards the clavicle. The eyeball may protrude. Severe pyrexia with rigors accompanies the local disturbance. Pain in the side, bloody sputa, and other indications of lung-implication follow, and the patient may succumb to pyæmic phlebitis in a week from the onset of the malady. In a small number of cases, however, the constitutional symptoms are less severe, and the inflammation is not so diffuse. In these, after free suppuration from several points of the surface, the lip may return to its ordinary dimensions, and recovery may take place.

The disease appears to be essentially a phlegmonous inflammation of the lips following a poisoned wound, and setting up thrombosis in the facial or external jugular veins. The clots are apt to extend upwards into the cranial sinuses, and detached portions may give rise to purulent foci in the lungs. On section of the lip, numerous small abscesses are found, and not a homogeneous slough, as in true carbuncle.

The *Diagnosis* from ordinary carbuncle will depend upon the virulence of the constitutional symptoms, the youth of the patient, the position and appearance of the swelling, its tendency to spread along the veins, and the condition of the subcutaneous tissues when incisions are made. Many have confused the disease with malignant pustule; but in the latter affection the vesicles are close together, and grouped in a ring round a central blackish slough; the swelling is remarkably free from pain, and there is no suppuration. In malignant facial carbuncle the pustules are scattered over the surface of the swollen lip; there is acute pain, and the deeper structures are full of small abscesses.

The *Treatment* is to support the patient with generous diet and alcoholic stimulants, to give large doses of quinine, and to make free incisions into the swollen tissues. These should be subsequently dressed with carbolic acid or some other antiseptic material. N. DAVIES-COLLEY.

CARCINOMA.— *Structure.*— A carcinoma may be defined as a tumour composed of epithelial cells, generally contained in alveoli, the walls of which are formed of fibrous tissue. The cells vary in shape and size, and as a rule closely resemble the epithelium of the part in which the tumour has originated. Their shape depends also on the amount of pressure to which they are subjected by the surrounding tissues; they are often multi-nucleated, and increase both by endogenous cell-formation and also by fission. The cells lie closely packed in the alveoli and are not separated from each other by any matrix. The blood-vessels are well-formed and run in the trabeculæ, not between the individual cells, as in the sarcomata. Lymphatics accompany the blood-vessels. The following are the chief groups of the carcinomata.

1. Epithelioma or squamous-celled carcinoma.
2. Rodent ulcer.
3. Spheroidal-celled carcinoma:—
    (*a*) Scirrhus.
    (*b*) Encephaloid.
    (*c*) Colloid.
4. Cylindrical-celled carcinoma; adenoid cancer; adeno-carcinoma.

1. Epithelioma.—*Clinical characters.* Epithelioma, or squamous-celled carcinoma, usually commences after forty years of age. It begins as a warty growth, raised to a varying extent above the surface, and at the same time growing to at least a proportionate extent into the subjacent tissues. It is this ingrowth that gives to epithelioma its typical induration. The growth generally becomes more or less papillated, and after a varying time the central part of the free surface tends to break down and ulcerate. In this manner it increases its area, spreading at the edges and ulcerating in the centre. Its progress is generally accompanied by much pain. The surrounding parts are infiltrated and destroyed by the new growth, which extends with much greater rapidity than does rodent ulcer; the neighbouring lymphatic glands are early affected, and the epitheliomatous mass in them runs a similar course to the original tumour. Not infrequently the glandular tumours increase even more rapidly than does the primary growth, and attain a greater size.

Secondary growths may occur in the viscera, but are comparatively rare. In untreated cases of epithelioma, the duration of life varies with the locality, and in some cases may extend over several years.

Symptoms.—When an epithelial ulcer is fully developed it is of a very irregular shape, with a deeply excavated and irregular base, greyish in colour, devoid of healthy granulations and secreting sanious pus; the edges are raised above the base of the ulcer and also above the surrounding parts; they are warty, sometimes ragged or fissured, and in places apparently undermined. On feeling the diseased part, it will generally be immediately discovered that there is a certain amount of new growth in the tissues, giving a sensation of induration around the ulcer to a varying extent; it will then be seen that it is the tumour itself which has ulcerated, and not the tissue in which it lies.

Diagnosis.—Epithelioma may be simulated by (1) innocent papillomas, (2) primary and tertiary syphilitic sores, (3) simple ulcers, (4) rodent ulcer.

(1) Simple warty growths and papillomas are generally easily separable from the epitheliomas; for in the former the tumour is essentially an outgrowth from the surface with little or no infiltration or hardness of the part from which it springs, with very slight tendency to destructive ulceration of any kind, and with but little vascularity, pain, or tenderness. Even in cases of long standing the lymphatic glands are not diseased. It is chiefly when inflamed or irritated that papillomas bear any strong resemblance to the malignant tumours, and it should be remembered that from the innocent papilloma an epithelioma may spring; if, therefore, there is any reasonable doubt, treatment by excision should not be delayed.

Venereal warts, especially when by pressure they have caused ulceration of the prepuce, occasionally grow in such a manner as to simulate epithelioma. The youth of the patient in most cases, and the history of previous urethritis in addition to the points just enumerated, will generally clear up any doubt.

(2) *Syphilitic Sores.*—Primary syphilitic sores, especially when occurring on the lip, may be mistaken for epithelioma. The youth of the patient in many cases, the very early and very extensive swelling of the glands, the amount of inflammation around, other evidences of syphilis, and the special characters of the sore, will in most instances enable the syphilitic chancre to be readily diagnosed.

Tertiary ulcers on the tongue and elsewhere are sometimes not readily distinguished from epitheliomas. Treatment often clears up the doubt, but it should be borne in mind that an ulcer, originally syphilitic, may become the seat of epitheliomatous new-growth. *See* Tongue.

(3) *Simple Ulcers.*—Simple fissures on the lips, chronic ulcers on the legs with thickened and raised edges, and, occasionally, simple ulcers on other parts of the body, occasion a slight difficulty in diagnosis, which readily clears up under adequate treatment. *See* Ulcers.

In all cases where there is doubt whether any given ulcer is epitheliomatous, a very small portion of débris from the ulcerated edge may be scraped away and put on a glass slide, in a little water, for microscopic examination. In most cases where the growth is epithelial, the cell-nests typical of this growth will be seen, either entire or in broken masses, in the field of the microscope, affording positive evidence of the nature of the ulcer. If such nests are not seen, their absence does not necessarily prove the innocent nature of the sore.

(4) For diagnosis from rodent ulcer see *Rodent Ulcer* later on.

Structure.—Microscopically, these tumours are found to consist of ingrowths of epithelial cells arranged in the form of papillæ, columns, or cylinders. On any skin or mucous surface these ingrowths may readily be traced to an excessive development of the interpapillary processes of epithelium, which will be found gradually dipping further and further into the subjacent tissues. As these epithelial processes grow more deeply they throw out lateral branches, and, these latter uniting with similar cell-growths from neighbouring cylinders, form a rude epithelial network. At the same time that this ingrowth of cells occurs, a similar outgrowth takes place, and a warty excrescence of epithelium is formed on the cutaneous or mucous surface. As the tumour increases in size, the more superficial and central cells perish and fall away, thus leaving the deeper parts of the epithelioma exposed. Such a condition as this is usually spoken of as 'ulceration,' though there is not present any true granulating surface.

The epithelial cells of which the cylinders are composed are usually large, very irregular in shape, often possessing processes, multi-nucleated, and sometimes evidently in the process of proliferating by endogenous cell-formation. Embedded in these columns are a varying number of cell-nests, sometimes very numerous in any individual specimen, in other cases scarce, but rarely entirely absent. They appear to be composed of one or more central cells of a rounded shape, and often smaller than their neighbours; sometimes these central cells appear to have degenerated, and their place is taken by broken-down, granular débris. Immediately around the centre are small crescent-shaped cells, with their concavity inwards, and outside these again are layers on layers of similar-shaped, but larger, cells. It is probable that the nests are formed by the very rapid proliferation of cells at various foci in the tumour, that the cells first formed at any focus are pushed towards the periphery by the constant and rapid growth in the centre, and become flattened or crescentic through the resistance offered by the surrounding tissues. The chief significance of a nest is that it indicates rapid cell-growth, and therefore when occurring in the deeper parts of the skin is diagnostic of epithelioma, for no such formation occurs under other circumstances in this situation; although nests may be present normally, though rarely, immediately beneath the free surface of the epidermis. Around the ingrowing columns there is generally evidence of irritation of the tissues into which the tumour is making its way, and each column is more or less surrounded by numerous leucocytes.

Locality.—The most common situations for epitheliomata are at the junctions of mucous and cutaneous surfaces. They occur on the lips—almost always the lower lip—and other parts of the face, the tongue, the larynx, the œsophagus, the rectum and anus; on the penis, the scrotum—as 'sweep's cancer'—the vulva, the os uteri; more rarely on the skin of the extremities or trunk, especially in the site of old scar-tissue or of sinuses long discharging, and occasionally on the scalp and ear, in the antrum, and in the bladder. Epithelioma never occurs primarily in bone, but, as in the case of the jaw-bone, it may extend into osseous tissue from a contiguous mucous or skin surface. For *treatment, see* MALIGNANT TUMOURS.

2. RODENT ULCER. — *Clinical characters.*—Rodent ulcer occurs late in life, but may certainly appear as early as forty years of age or even earlier. Its common situation is the face, preferably the inner angle of the eyelids. Typically, it commences as a small wart, the centre of which ulcerates; the growth of the wart and the spread of the ulceration progress with about equal rapidity, so that at no time is there any large amount of new-growth; frequently the ulceration heals in one place while it spreads in another; the scar, when formed, is liable to again break down.

The growth of a rodent ulcer is essentially slow, yet the rate of its progress differs much in different cases. Sometimes, after an interrupted course of fourteen or fifteen years, the whole extent of the ulcer is not greater than could be covered by a half-crown piece, whilst, in other cases, large portions of the face may be destroyed within five or six years. The growth appears to extend most rapidly when it occurs at a relatively early age.

When fully developed, a rodent ulcer is a flattened growth of an irregular shape, with a grey, smooth, and glazed base, devoid of healthy granulations, discharging watery pus, cicatrised here and there, with edges raised above the level of the ulcer and of the surrounding parts. Rodent ulcer never causes glandular infection, though the glands may become inflamed, and even suppurate. But, although the above description is true of typical cases of this disease, it is a fact that a rodent ulcer may, though very rarely, attain a considerable size without ulcerating at all, the surface remaining warty and tuberous.

At first a rodent ulcer tends to spread superficially, but, when it reaches bone, its progress is much more rapid, and the osseous tissue is quickly excavated and removed. Thus, in advanced cases, a great part of the skin of the face, the eyeballs, the nasal cartilages and bones, and portions of the calvaria may be entirely destroyed, so that the patient comes to present a most hideous appearance. Yet, even in this condition, life may be prolonged for years, for the distant viscera never become the seat of disseminated growths.

Diagnosis.—The diagnosis must be made from (1) Epithelioma; (2) Lupus; (3) Syphilitic ulcers.

(1) Rodent ulcer must be more especially separated from epithelioma. The first and great difference is found in the much slower progress of rodent ulcer; roughly speaking, epithelioma will grow as much in a month as a rodent ulcer in a year. Yet, here also care is necessary, for epitheliomas may originate in warts or pimples of long standing, so that a patient may, unless carefully questioned, unintentionally mislead the surgeon who asks him how long he has had the disease. In rodent ulcer, the ulcerated surface cicatrises in parts; epithelioma never cicatrises; but it must be remembered that in some rodent ulcers the surface is warty rather than ulcerated, though this is quite the exception. Rodent ulcer never affects the glands, epithelioma, after a longer or shorter period, almost invariably does. The amount of new-growth is generally much greater in epithelioma than in rodent ulcer, and the surface is more warty. Rodent ulcer does not occur in the most favourite sites of epithelioma.

(2) From ulcerative lupus rodent ulcer may be diagnosed as follows:—Lupus almost always *commences* before adult life, though it may *recur* in old age. It commonly occurs in strumous subjects. There is no evidence of warty new-growth; around the edge of the ulcer there are sometimes small tubercles which, by their breaking down, cause an increase in the extent of the sore; under constitutional treatment a healthy granulating surface may result, and a sound scar be formed.

(3) Tertiary syphilitic ulcers may be diagnosed from rodent ulcer by the early age of the patient in many cases; the evidences of syphilis; the presence of pigmented scars around; the much greater rapidity of the ulceration; the semicircular or serpiginous shape of the sore; the absence of all new-growth; and the success attending the employment of anti-syphilitic remedies.

Structure.—A rodent ulcer is a growth composed of embryonic epithelial cells, and must, therefore, be included amongst the carcinomata. Microscopically, it is found to consist of an overgrowth of epithelial cells in the deeper portions of the skin, often apparently commencing in the sebaceous glands. The growth invades the subcutaneous tissues in the form of large, flask-shaped ingrowths, frequently separated from each other by several normal papillæ and interpapillary processes of epithelium. The cells of which these ingrowths are composed are evidently epithelial, but, nevertheless, differ very markedly from those of the rete Malpighii and of the squamous epitheliomata, chiefly in being much smaller. In their further growth they differ again from the cells of epithelioma in their tendency to become vacuolated, and thus to form spaces in the centre of the ingrowing masses, and in that, with the most rare exceptions, they never form cell-nests in the epithelial columns, as do the cells of epithelioma. In rodent ulcer perfectly normal inter-papillary processes may often be found in the midst of the new-growth. This is never the case in epithelioma. The growth in rodent ulcer probably springs from the glandular epithelium in some of the appendages of the skin, and it is owing to this difference in origin that the tumour-growth differs from that of epithelioma, in which the growth always commences in the surface epithelium.

Locality.—Rodent ulcers are almost invariably met with on the face above the level of the mouth; perhaps their most common seat is the side of the nose and the inner angle of the orbit. They are sometimes found upon the ear and the scalp. For *treatment, see* MALIGNANT TUMOURS.

3. SPHEROIDAL-CELLED CARCINOMAS.—The spheroidal-celled carcinomas are subdivided into *a.* Scirrhus; *b.* Encephaloid; *c.* Colloid.

Clinical Characters.—Both scirrhous and encephaloid cancers are most commonly met with between the ages of forty and sixty; they may occur, however, either earlier or later than these limits. Typically, a *scirrhous carcinoma* commences as a firm, nodular mass, which is at first painless, and so may attain considerable size before being noticed by the patient. An examination at an early stage of its growth reveals the following characters:—A tumour of variable size, surface irregular and nodulated, very hard indeed to the touch, often fairly movable in the tissue or gland in which it lies—e.g. in the breast—not very painful or tender; glands, if enlarged, very hard and freely movable. The rapidity of growth varies greatly, so that in some cases of so-called atrophying scirrhus the tumour may be no larger than a walnut after some three or four years' growth. Such cases are almost confined to the old, and are rare. After a varying time the tumour becomes fixed to the surrounding tissues; the skin becomes dimpled, puckered, and adherent; the patient suffers lancinating or stabbing pain, and the tumour is tender on pressure; the glands which are affected alter in character, just as does the original growth. *See* BREAST, Diseases of the; MALIGNANT TUMOURS.

Secondary growths in the viscera are common in cases of scirrhus, and the bones sometimes become brittle and fracture spontaneously. It is doubtful, however, whether the fragility of the bones exists except in connection with the development of cancer-elements in their structure. Sometimes scirrhous carcinomas are primarily multiple.

Medullary carcinomas grow much more rapidly than the scirrhous tumours, and early become adherent to the surrounding parts. They attain frequently a great size, and to the touch are soft or elastic, and sometimes fluctuating in places where they have undergone cystic degeneration. In their further development they run a course similar to that described as typical of the growth of malignant tumours in general. *See* MALIGNANT TUMOURS. Metastatic growths are frequent, and the patient often succumbs within a year from the commencement of the disease.

The clinical characters of the *colloid cancers* are identical with those of the other spheroidal-celled carcinomas, the type varying in different cases, and resembling in some cases a scirrhous, in others a medullary, growth.

Diagnosis.—These tumours, when occurring in secreting glands, as is usually the case, must be distinguished from (1) the sarcomata; (2) cysts; (3) abscesses.

(1) From the sarcomata they may be diagnosed (*a*) by the greater age of the patient in whom they (the carcinomata) usually occur. Thus sarcoma of the testis occurs in the young, and even in infants; carcinoma in middle age or late in life. (*b*) By the presence of glandular affections in the carcinomas when the breast is the organ diseased, and by the absence of glandular affection in all sarcomas of the same part. (*c*) By the greater softness and more marked lobulation of the sarcomata, by the absence of puckering and retraction of the skin, and also of the nipple when the breast is the seat of sarcomatous growth. Carcinomas rarely grow in the parotid. In the testis it is often impossible to decide the true nature of a malignant growth.

(2) From deeply-seated cysts and (3) chronic abscesses of the breast the diagnosis is often difficult, and, in some cases, impossible. The age of the patient, a recent pregnancy or miscarriage, the greater softness and tenderness of any enlarged axillary lymphatic glands, œdema of the skin, with widely diffused tenderness, and, perhaps, an indistinct sense of elasticity or fluctuation, will all make probable the presence of a chronic abscess. In cases of doubt, exploratory puncture should always be resorted to.

Spheroidal-celled carcinomas sometimes commence in the skin, which rapidly gives way, and allows of the formation of a 'cancerous' ulcer with a fungating growth. Diagnosis must be made from inflammatory swellings and from the sarcomata. The rapidity with which the tumour increases, together with its hardness, the affection of glands, and the absence of suppuration, will generally admit of a diagnosis being readily made. *See* ULCERS.

Structure.—The spheroidal-celled carcinomata spring from the epithelium of the various secreting glands.

The tumour always commences by a proliferation of the glandular epithelium. The cells, increasing in number, first fill the acini and ducts, and then, continuing to proliferate, extend into the surrounding tissues. There, their presence causes a certain amount of irritation and consequent proliferation of the connective-tissue elements, and they thus become surrounded by leucocytes. In the usual course of events the leucocytes become developed and form connective-tissue bands around the growing epithelium cells, which in this way become shut up in spaces or alveoli. Later on, this newly-formed fibrous tissue tends to contract and become more dense, in exactly the same manner as does scar-tissue; and as the oldest parts are always the most central, it is in the centre that the firmest portion of the tumour is to be found.

Considering that a certain amount of time is requisite in order to allow of the formation and contraction of this fibrous stroma, it will readily be understood that it is most abundant in the more slowly-growing tumours. It is, therefore, most plentiful in scirrhous carcinomata. On the other hand, in the rapidly increasing encephaloid growths, the walls of the alveoli are extremely thin.

(*a*) Scirrhous Carcinoma.—*Examined microscopically*, a scirrhous carcinoma is found to consist of epithelial cells lying in a connective-tissue stroma composed of interlacing bands of fibres. The spaces, or alveoli enclosed by these bands, are very irregular both in shape and size, and are smaller towards the centre of the tumour than at its periphery. Lying within the alveoli are numerous epithelial cells of different shapes, often undergoing fatty degeneration in the more central parts of the growth. Where the stroma is most loosely arranged, as at the edge, the cells are larger and more evidently epithelial than in the central and denser portions of the tumour; they often possess several nuclei and nucleoli.

In the larger alveoli as many as thirty or forty, or more, cells may be massed together; whilst in other parts they lie in single file, in groups of two or three, amidst bundles of connective tissue. Intimately mingled with the constituents of the tumour, as just described, are numbers of small round connective-tissue cells and young connective-tissue fibres; they are most abundant at the periphery of the growth.

To the naked eye a scirrhous cancer presents itself in its most typical form as an opaque, white, fibrous mass, very firm and dense, concave on section, and with an irregular margin. At the edge of the tumour there will often be seen small masses of the surrounding fat or other normal structures which are being infiltrated by the tumour, and which have, as it were, been entangled by the new-growth preparatory to being absorbed. There is no attempt at encapsulation. The surrounding tissues are puckered and drawn in towards the tumour mass, which sends into them irregular branching processes. On scraping, the tumour yields a milky juice.

In other cases the tumour is more succulent and lobulated, and not so definitely fibrous; whilst in rare instances there is a general infiltration of the tissue with new-growth and no very definite tumour is found. The appearance of a scirrhous cancer will further differ according to the amount of degeneration it has undergone, so that in some instances cysts containing a bloody fluid will be found in the centre of the growth. Where the tumour has developed in the breast, it is very common to find the remains of the ducts in the midst of the new-growth filled with inspissated secretion, which may be squeezed out in small masses somewhat similar to the secretions found in the sebaceous glands in acne.

Locality.—By far the most common seat of scirrhous carcinoma is the female breast; but this form of cancer is also found to occur primarily in the œsophagus, the stomach—especially at the pylorus—the bladder, the rectum, and the skin.

(*b*) Encephaloid Carcinoma.—*Microscopically examined*, an encephaloid carcinoma consists of an alveolar stroma containing masses of epithelial cells. In a typical case the alveolar walls are very thin, and are frequently composed of spindle cells and young, half-developed fibres. The general outline of the alveoli is more rounded, and their size more regular and much larger than in the case of scirrhus. The contained, numerous, closely-packed epithelial cells are large, with clear cell-bodies, many nuclei, and a large number of nucleoli. The bulk of the tumour is cellular.

To the naked eye, on section, an encephaloid carcinoma shows a soft, greyish or brownish-grey, brainlike mass, frequently containing cysts, very readily breaking down into a pulp, and nowhere bounded by a capsule.

Locality.—The female breast and, more rarely, the testis, stomach, bladder, rectum, and skin. Encephaloid carcinomata are much more rarely met with than the scirrhous variety. Their supposed frequency depended on their having been only of late years separated from the brainlike sarcomata.

(*c*) Colloid Carcinoma.—This is but a name given to a spheroidal-celled carcinoma, the cells and stroma of which have undergone degeneration. The alveolation is usually well-marked, but in places the fibres have become swollen and indistinct or hyaline; occasionally two alveoli run together through excessive degeneration of their walls. The cells are often indistinct and swollen, with the exception of their nuclei, which are generally well-marked and stain deeply. Frequently the nuclei alone can be distinguished, but in other cases the cell-body may be seen distended with colourless, homogeneous, colloid matter.

To the naked eye a colloid carcinoma presents a very typical appearance, looking like an irregular meshwork, the spaces of which are filled by a clear, jelly-like, or slightly opalescent, gelatinous substance. Towards the periphery this appearance is less marked. These tumours are never encapsuled.

Locality.—Colloid carcinomas are most common in the stomach, but are found also in the intestines, the breast, and very rarely in other parts of the body.

4. CYLINDRICAL-CELLED CARCINOMA OR ADENOID CARCINOMA. — *Clinical characters.* — Cylindrical-celled carcinomas vary much in their clinical course and characters. In some cases they exist for many years without attaining any great size, without affecting the neighbouring glands, and without becoming disseminated. In other cases, they grow rapidly, fungate and bleed, affect both glands and distant organs, and rapidly destroy life. It is not possible to say, from a microscopical examination of such a growth, what course it will run.

The diagnosis of these growths will be found discussed in the article on the diseases of the RECTUM.

STRUCTURE.—These tumours, like the spheroidal-celled carcinomata, originate in the secreting glands. Microscopically examined, they are seen to be composed of tubules lined with columnar epithelium, arranged so as to form a central lumen, after the manner of a simple tubular gland, and in addition to this growth, which possesses the appearance of a simple adenoma, there is generally present a considerable overgrowth of epithelium, not arranged after the glandular type, but occurring as masses of cells grouped in greater or less number in an alveolar stroma after the manner of a scirrhous cancer. Between the latter typical carcinomatous structure and the adenomatous growth all intermediate steps can be readily traced.

The structure of the alveoli does not materially differ from that already described as occurring in the spheroidal-celled carcinomas, but the cells are columnar or cylindrical in shape, and are generally numerous, large, and well-developed.

To the naked eye, the cylindrical-celled carcinomas present themselves as villous or papillary tumours of whitish hue, infiltrating the deeper tissues to a varying extent, and never encapsuled.

Locality. — Adenoid carcinomas occur most frequently in the rectum; much more rarely in the superior maxillary bone, the uterus, the bladder, and the stomach.

MELANOTIC CARCINOMAS. — Deposit of pigment in carcinomatous growths is rare, and may be said to be limited to a few cases of epitheliomata. Almost all melanotic growths are sarcomas. *See* SARCOMA.

For the Etiology and Clinical characters of malignant tumours, and the Treatment of the carcinomata, *see* MALIGNANT TUMOURS.

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CARDEN'S AMPUTATION. *See* KNEE-JOINT, Amputation at the.

CARIES implies molecular death and disintegration of bone, attended with suppuration. The same kind of changes which occurs in ulceration of the soft tissues, is expressed by the term caries when bone is the part under consideration. The word has been used in very various ways, as, for example, in 'caries sicca,' to express inflammation of bone without suppuration, and it has thus led to considerable confusion. But it would be far better to call such cases ostitis, rarefying ostitis, tubercular ostitis, and so forth, using the term which seems most appropriate for each, and to limit the term 'caries' to those cases in which suppuration has occurred. It may be understood from this that ostitis not unfrequently terminates in caries.

Causes.—The same causes that give rise to inflammation of bone, and that are considered under OSTITIS, may produce caries. Some slight injury is often the exciting cause. But struma or tubercle is generally present, and these two diseases may be looked upon as the special conditions—if indeed they are distinct from one another—which are mainly responsible for the commencement of caries. Caries is also sometimes caused by syphilis, and is then peculiarly intractable, being generally the result of a broken-down gumma in the periosteum and superficial layers of the compact bone. It would, in this superficial variety of the disease, be very properly described as ulceration.

Pathology.—Caries is met with chiefly in the short spongy bones, such as those of the carpus, tarsus, and the vertebral column, or in the cancellous tissue of the articular extremities of the long bones. The first stage of the process is probably 'rarefying ostitis,' although some pathologists assert that it begins as a fatty degeneration of the bone-cells in the lacunæ. According to this theory, the trabeculæ being killed by the death of their cell-elements act as foreign bodies, and set up suppurative inflammation around them. But whatever be the primary condition—a condition which need not here detain us—inflammation of a low and chronic kind is eventually established. The periosteum becomes much thickened, highly vascular, and loosened from the bone. Its under surface is rough and covered with a layer resembling granulations which fit into the enlarged openings of the Haversian canals. The latter are dilated and their connective tissue infiltrated with inflammatory exudation, which develops slowly into granulation-tissue. The bone thus becomes more open and spongy, so that the cortical part resembles cancellous tissue. Pus, thick and curdy, is very slowly formed, and finally—perhaps after many months—makes its way to the surface as a chronic abscess. In this rarefying ostitis, some parts of the bone may not have melted away so quickly as others, and, being cut off from their nutritive supply, may perish. When this occurs, and sequestra are found in a carious cavity, the condition is called 'caries necrotica.' This is not uncommon in tubercle and syphilis. In some cases very little pus is formed, and the cancellous spaces enlarged by the absorption of their bony walls are filled with vascular granulation-tissue. This fungating form of caries ('caries fungosa') is especially common in the spongy bones, and in the epiphyses of the long bones, where it often opens into the neighbouring articulation, as is described in the article on joint-diseases. After a varying length of time, the fungating granulation-tissue undergoes fatty degeneration, which is then followed by softening and suppuration. Fatty degeneration and softening do not, however, necessarily ensue, and the cavities may remain filled for a variable length of time with the pink gelatinous granulation-tissue, which is again slowly absorbed, leaving the bone smaller and shorter than it was before. This variety, which is called 'caries sicca,' is seen occasionally in the articular extremities of a long bone, and produces considerable shortening of the extremity without suppuration. In the early stage of almost all these forms of caries, at a time when the disease corresponds chiefly to the rarefactive type of ostitis, some new bone is generally produced in the neighbourhood of the inflamed area, so that the bone appears enlarged.

Symptoms.—The symptoms in the early stage of the disease may be those only of ostitis, which will be found described under that heading; or the increased size of the part may be less evidently due to an enlargement of the bone itself than to a deep-seated swelling of the tissues in immediate contact with it. The presence of pain at night, the persistence of the tumefaction, and the tenderness on deep pressure, will then be the chief points indicating the presence of inflammation of bone which may terminate in caries. Often, however, a swelling which proves on examination to be a chronic abscess, is the first sign which the patient has himself recognised of the disease. The mere fact of the accidental discovery of such a chronic abscess will arouse the surgeon's suspicion of the case being one of caries.

Occasionally, the patient comes under observation for the first time with the sinus, which has resulted from the opening of the abscess already formed. Then the probe decides at once upon the nature of the case. It may sometimes be a little difficult to reach the bone, particularly in cases in which the sinus has existed for a long time, and the bone is not superficial. If, after a careful and fair trial with the probe, bent and moved in various directions, the bone has not been touched, and the impression is left on the mind that the end of the sinus has not been reached, then the fistulous opening may be enlarged to facilitate the movements of the probe, or Sayre's vertebrated probe may possibly be of service, but the writer has not much confidence in the use of this latter instrument. The character of the sinus and its discharge may also throw some light upon the nature of the case. The button-shaped, pouting granulations, which surround the opening, too surely indicate the presence of diseased bone at the bottom of the sinus, and in caries they are generally more fungating and œdematous than in necrosis. The discharge is also thin and watery, containing frequently small, gritty particles of bone; it may also be offensive if putrefaction be not prevented by suitable treatment. The probe, as it strikes upon the carious part, fails to elicit the clear, sharp, ringing sound which is generally noticeable in the case of necrosis, but conveys the impression that the bone is rough and bare. Being also spongy and fragile from the nature of the disease, it not uncommonly gives way before the pressure of the probe.

Treatment.—The general treatment in caries is more than usually important, for the operations which are undertaken for its relief are not so uniformly successful as in other diseases of bone. If there be any grounds for suspecting syphilis to be the cause of the disease, iodide of potassium alone, or in combination with mercury if the former fail, must be given in gradually increasing doses, in the manner described under Periostitis.

Struma or tubercle being, however, the most frequent cause of caries requires more than a passing mention as to its treatment. Cod-liver oil probably holds the foremost place amongst the constitutional remedies in caries as in other strumous or tubercular affections. Iron and the iodides may also be of service. But, in the young, change of air, and especially to the seaside, will often bring about a successful result when no other treatment seems of any avail. It is truly astonishing to see the progress such cases make when they are sent from a London hospital to the Margate Infirmary.

As far as local treatment is concerned, rest and free openings for the discharge are the first and most important indications. Rest should be obtained, where it is possible, by a splint, and in the case of the foot by a knee-rest, so that the patient may not be confined to bed. Incisions should be made in dependent places when the discharge does not seem to escape with sufficient freedom. If the case come under observation before the abscess has opened, the incisions and subsequent dressing should be conducted with antiseptic precautions. A drainage-tube should be inserted, and some antiseptic absorbent wool will generally be found to be the most convenient form of dressing. Sufficient time having been allowed to elapse for these general and local remedies to take effect, the question arises what operation, if any, should be adopted; and here considerable latitude must be given to differences of opinion, according to the special features of the case. Some surgeons hold that there is very little to be gained by gouging away the diseased part; that if it becomes absolutely necessary to interfere on account of the exhaustion produced and the intractable nature of the disease, the choice of operation lies between excision of the whole bone affected, and amputation of the limb. Without going thus far, we may infer, from this opinion, that gouging away the diseased part of the bone is not held in very high favour. Such partial operations on bone were, in former days, peculiarly prone to be followed by pyæmia. The latter is not so frequent now that every surgeon makes thorough and effectual endeavours to prevent the occurrence of decomposition in the discharge which would otherwise necessarily ensue. The disease must, however, be chronic before such an operation is undertaken.

The limb should be rendered bloodless by Esmarch's bandage, so that the limits of the disease may be clearly defined. This is more essential in caries than in necrosis, for the diseased area is surrounded by rarefied bone, which is not easily distinguished from caries. The difference between the two is generally indicated by the crumbling non-vascular, almost white condition of the latter, whilst the healthy, although inflamed, bone, is firmer and more resistant to the gouge, and on removal will be found pink and vascular. Gouges of various shapes and sizes may be required, and Volkmann's sharp spoons may also be of great assistance, especially in the removal of granulations, which should be all cleared away. The cavity should then be sponged out with chloride of zinc from gr. xx. to gr. xl. ad f℥j., and some absorbent dry dressing, such as iodoform or salicylic wool, applied. This will not require changing for some days, and, after the first redressing, may generally be left untouched for a week.

Instead of using the gouge, some surgeons prefer the actual cautery, and Mr. Pollock has recommended the application of sulphuric acid, diluted at first with an equal quantity of water, and then more nearly pure. As soon as the eschar thus formed can be removed, the sulphuric acid is again applied, till a healthy surface of granulations is obtained. Mr. Holmes speaks favourably of this treatment, as also of that by the actual cautery.

Where the small bones are the parts diseased, such as those of the tarsus or carpus, excision, with or without the periosteum, is often the best operation, if the caries involves the greater part of the bone. This is especially the case in the os calcis; but if more than one bone is involved, amputation will probably be required.

The other small bones, entering into the formation of ankle- and wrist-joints, are more properly considered under Joints, Diseases of.

Amputation is very rarely required for caries, except in the case of joints, the diseases of which are considered in another article. H. H. Clutton.

CARIES OF THE SPINE (Pott's Disease).—This is especially a disease of childhood. It may begin in the first year of life, and even, it is stated, *in utero*. Most cases are under sixteen years of age. It has been known to begin at seventy years (Ogle). Both sexes are said to be equally affected, though the writer's figures give a preponderance of twenty-five per cent. to males.

A remote constitutional cause can be generally traced in scrofula or tubercle; the exanthems, especially scarlatina and measles. In adults, syphilis in the form of gumma (Fournier), or following syphilitic pharyngitis. An immediate cause is often local injury, from falls, blows, strains; while certain occupations seem, at times, to account for it, e.g. those of well-sinkers, signalmen, compositors. Violence is almost necessarily applied indirectly to the vertebral bodies, which are more subject to strains than other forms of injury, at their unions with the discs.

Pathology and Course.—Caries of the spine begins usually at the junctions of the bodies of the vertebræ and the intervertebral discs. Even in advanced cases the laminæ and spinous processes escape. In atlanto-axoid disease it begins as a synovitis of the joint. The onset is insidious, the course chronic, occasionally only rapid and acute; but the pathological conditions in no way differ from those of caries of the other cuboid bones, or of the spongy ends of long bones. Since the flat surfaces of the vertebral bodies are epiphyses, caries may be regarded as commencing as an epiphysitis or articular ostitis.

Caries destroys the intervertebral discs and adjacent bone above and below, thus contrasting with the absorption due to pressure of aneurism—also a cause of angular deformity—in which the cartilages remain intact after the bone has disappeared. The bone-destruction may be quite superficial, and be only suspected when abscess has formed; it may, though rarely, begin in the spinal canal on the posterior surfaces of the bodies under the posterior common ligament. Any matter thus formed lies outside the theca vertebralis. At times there is necrosis as well as caries. Sequestra may be discharged externally, or be found at the autopsy in the cavity formed in the spine, and unsuspected during life.

Suppuration does not necessarily accompany spinal caries; but it may exist, yet never be seen, during life (e.g. it may form an abscess in the posterior mediastinum). Its extent is not proportionate to the apparent extent of disease, nor can it be predicted in any case. It may be the earliest objective sign, or it may be the last symptom in a case. The writer's figures show visible suppuration in about twenty-five per cent. of all cases.

Where suppuration is absent—*caries sicca*—the bodies of the vertebræ, in lieu of being destroyed so as to produce a larger or smaller continuous chasm in the front of the spine, are seen sometimes to be honey-combed by the carious process and filled with granulation-tissue, a condition known as *myelitis granulosa.* Extensive disease may then exist without deformity, the bodies being perforated rather than destroyed. But little practical good results from a distinction between suppurative and non-suppurative caries, for, as stated above, the absence of visible suppuration does not preclude the pathological probability of its existence. Most frequently there is but one focus of disease, and this involves one or many vertebræ, but two or more may be present in different parts of the spine. They may be contemporary or successive.

In proportion as the bodies and discs are destroyed, so will the second stage of the disease be reached—that of deformity or *angular curvature*—but deformity is absent where the caries is only superficial. The weight of the superincumbent trunk and limbs causes the bone above the cavity in the bodies, formed by the disease, to approach that below it until they meet; the spines of the intervening diseased vertebræ are protruded posteriorly as a knuckle or boss. Where a vertebral body is only partly destroyed or only softened by inflammation, the pressure described will cause it to become wedge-shaped, the base of the wedge being posteriorly, and its spine will unduly project.

The largest and most quickly formed bosses are to be seen in the dorsal region, simply because in the mid-cervical and lumbar regions there is a natural concavity of the spine backwards, which must be obliterated before a posterior projection can occur, but the dorsal spine is naturally convex posteriorly. In the cervical region disease of the third or fourth vertebra shows itself rather as a thickening than a distinct boss, and in the last three lumbar vertebræ a boss is rare. These vertebræ are so firmly interlocked, and are so broad, and their large transverse processes give such powerful muscular attachments, that the back can be held rigid and straight.

The most common seat of disease is between the first lumbar and twelfth dorsal vertebræ (Hueter). The writer's cases show the dorsi-lumbar region (second lumbar to tenth dorsal) as most frequently diseased, and, after that, the following is the order of frequency: dorsal, lower lumbar, cervical vertebræ, cervico-dorsal (seventh cervical to third dorsal), atlanto-axoid articulation.

In the occipito-atlantoid, atlanto-axoid, and sacro-coccygeal regions disease begins as a synovitis of the respective joints. It is usually chronic, but death in two weeks from pyæmia, after acute synovitis of the atlanto-axoid articulation, is recorded. In the atlanto-axoid articulation the left side is more frequently affected than the right (Rust). From the joint the disease spreads to the arch of the atlas and body of axis, portions of which—or even the entire odontoid—may come away as sequestra through a post-pharyngeal abscess. The deformity in atlanto-axoid disease is peculiar. Where both joints are diseased the head and atlas slide bodily forward upon the axis, the spine of the axis forming an apparent boss, with a deep sulcus between it and the skull. Where one joint is affected that side only is projected forward, and hence the face looks to the opposite or sound side.

Narrowing of the spinal canal, as the result of deformity, is not seen in angular curvature. The anterior wall of the canal being gone, there is, even in extreme curvature, positively more room for the accommodation of the cord, whilst the chronicity of the change gives time for the cord to accommodate itself to the altered shape of its chamber. But in atlanto-axoid disease, where the atlas slides forwards upon the axis, the canal is narrowed, the posterior arch of the atlas gradually approaching the odontoid process, and as gradually are the functions of the cord interfered with, and death results. Yet extreme narrowing, if gradual, is not necessarily fatal; a man has lived years with only a quarter of an inch between the arch of the atlas and the odontoid, and that without any subjective symptoms; a lad, æt. fifteen, has lived some time, though with gradually increasing paralysis, in whom, at death, the canal at this point measured but three lines in the same direction (Paget).

Angular curvature in the cervical and cervico-dorsal regions causes dyspnœa from the forcing of the chin on to the sternum; in the mid-dorsal region it deforms the chest, reducing its vertical depth and interfering with the action of heart and lungs; in the lower dorsal region it bends the thorax upon the abdomen and interferes with the digestive organs, causing mechanical dyspepsia and frequently intercostal neuralgia.

The formation of pus causes fresh pathological states. It may appear externally as abscess (*see* PSOAS, LUMBAR, RETRO-PHARYNGEAL ABSCESS), or it may remain concealed behind the peritoneum or in the posterior mediastinum, and may be unsuspected till it breaks into a viscus or serous cavity. It may occur at any period of the disease, or not at all; or, as a residual abscess, when apparently complete repair has taken place.

Interference with the functions of the spinal cord is specially correlated to the presence of pus. Chronic meningo-myelitis is the result of caries and suppuration in the proximity of the theca vertebralis, though pus may travel along the canal at times without doing any harm. The condition is one of thickening of the meninges with caseation, with inflammation of the cord, or even complete suppurative disorganisation. This is not confined to the level of the bone-disease; it spreads upwards and downwards; lumbar caries has been known thus to produce fatal cerebro-spinal meningitis. Acute cerebro-spinal meningitis in caries of the spine is always, or nearly so, due to miliary tubercle.

The paralysis of spinal disease is motor, and explained by the proximity of the disease to the anterior columns of the cord; in advanced cases anæsthesia may follow; paralysis of sensation is unusual as an early symptom; it then only amounts to numbness. Paralysis is due to inflammation in meningo-myelitis, or to pressure from confined pus or blood (e.g. ulceration into vertebral artery), and in atlanto-axoid disease, to the presence of displacement. It is rarely complete at first; it is ingravescent; it may affect one limb or be symmetrical, or in cervical disease may involve an arm and the opposite leg. In the paraplegic form the rectum and bladder usually escape; the patient, though unable to walk, retains power over his evacuations. Evidently recovery depends upon the cause of the paralysis. Cases due to pressure are the most favourable: paralytic attacks may be repeated, recovery occurring between each; when sensation is lost it is recovered before motion.

Death in spinal caries results often from exhaustion by suppuration or septicæmia, especially where abscesses have been opened non-aseptically; from hæmorrhage due to abscess opening into an artery, as the vertebral or iliac; from suppurative peritonitis or pleurisy; pneumonia; tuberculosis; amyloid disease; meningitis; and the sequelæ of paralysis. In atlanto-axoid disease, gradual or sudden pressure upon the cord from dislocation of the bones, and suffocation from the bursting of a post-pharyngeal abscess, are special fatal results.

Symptoms.—It is of vital importance to recognise spinal disease before the advent of the later stage of angular curvature; yet many cases do not seek relief till a boss is developed, the premonitory signs having been so slight. Pain is generally an early symptom, of a dull, aching, gnawing character, situated in the back, with a sense of back-weakness. The pain is aggravated by movement, pressure, or jarring, and quickly relieved by complete rest. It is accompanied at times by muscular spasm and cramp; the former in cervical disease causing wryneck from rigidity of the sterno-mastoid muscle, the latter, when in the legs, producing a peculiarity in the gait. Neuralgic pains are referred along the course of the nerves near the roots of which the disease exists, hence sciatica and intercostal neuralgia; in mid-dorsal disease there is pain at the pit of the stomach, or a sense of constriction round the belly; in cervical disease, neuralgia of the brachial plexus, and in the scalp along the great occipital nerve (Hilton).

Children with early caries are seen lolling about, undesirous of play, uncompanionable, out of temper, and clearly show they wish to be left alone. When standing they hold on to the furniture, or even rest their hands and chins on the edge of the table. Their complaints of pain are very vague: it may be situated in the back, but as likely as not in the legs or belly, and from standing with one hand on the thigh to give support to the back, are usually suspected by parents of hip-disease, or all is explained as 'growing pains.' They strut instead of walking, which is due to holding the back stiff to prevent movement of the inflamed parts; but cramp or spasm of the calves sometimes gives a peculiarity in walking. When stooping to pick up an object, one hand is placed on the thigh, and the child reaches the ground with the other hand by bending the knees, or may at once kneel outright.

Firm pressure over the vertebral spines reveals a tender spot; and pain at the same place is manifested by pressing on the patient's head or shoulders, or by jarring the back; spasm of the erector spinæ is also present, and occasionally local heat and hyperæsthesia of the skin to heat and cold. By lifting the shoulders of the patient, and removing the weight of the trunk from the diseased bone, the pain is usually much relieved. When in later stages angular deformity is present, the case is easy to recognise; the boss is formed of one or of several spinous processes, and is accompanied by the thoracic and abdominal deformities already mentioned, when in the dorsal region.

In the cervical region special symptoms are present. Muscular spasm causes wryneck; from the forward position of the head the patient appears short-necked, and either a boss or thick convexity of the spine is felt posteriorly. Though commonly the chin approaches the sternum, sometimes in young children the head is thrown spasmodically backwards; the whole body is turned in lieu of rotating the head (but this is not confined to atlanto-axoid disease), and expiration is accompanied by a characteristic grunt; when dysphagia is also present, retro-pharyngeal abscess must be looked for. When standing or sitting the head will be supported by the hands. In disease of the atlanto-axoid articulation grating on forced rotation of the head may be at times felt, and the whole head is preternaturally forward, or the face looking to one side, for reasons given above. In advanced disease from gradual narrowing of the canal there is dyspnœa, with a sense of impending death, making the patient afraid to lie down; the supine position may even cause death by pressing the head forwards, were not a small pillow placed under the nape (Hilton). Equally dangerous is it to allow the patient to lean forwards.

The paralysis of spinal disease in children is often early overlooked or ascribed to clumsiness; hence, stumbling constantly in walking, and falling unduly at play, should excite suspicion. In adults the gait becomes shuffling, and numbness, neuralgia, and persistent cramp are at times the precursors of paralysis. Paralysis appears at all stages of the disease, and is, at times, the first symptom that attracts attention; there may be no objective sign of disease, but local tenderness in the spine will be present on careful examination.

When, accompanying paralysis, there is much rachalgia, with spasm of muscles, shooting pains and cramps, meningitis is likely to be present. When, later, the paralysis is complete, with loss of sensation and paralysis of the sphincters, profound changes in the cord from myelitis or pressure must be suspected. A sudden onset of complete paraplegia, with fever, delirium, cerebral symptoms, and optic neuritis, ending fatally, in the course of spinal caries, points to cerebro spinal meningitis due to acute tubercle.

Diagnosis.—In the later stage of angular curvature no difficulty occurs in diagnosis;

though the possibility of aneurism, or tumour (hydatid), must be remembered.

In the early stage, any one of the subjective symptoms before mentioned may be the first complained of. In adults, numbness of the limbs, unsteady gait, persistent cramp, sciatica, neuralgia, constricting pain round the belly, especially excite suspicion of spinal disease. In children, so-called 'growing pains,' aversion to exertion, fearfulness of sudden movement, a desire to lie down, or to lean when standing, any peculiarity in walking, persistent 'stomach-ache' without derangement of the bowels—in a word, acting the malingerer from school, should never be disregarded. Pathognomonic of atlanto-axoid disease are stiff-neck, forward or sideway position of face, and posterior hemicrania (neuralgia of great occipital nerve).

In seeking for local pain in suspected cervical disease, it must be remembered that pressure over the fifth vertebra is distinctly painful, as compared with that over the other vertebræ, even in healthy people; and the vertebra prominens must not be mistaken for a boss. Both these mistakes the writer has seen made.

Treatment—(*a*) of caries of the spine; (*b*) of angular curvature.

(*a*) When the disease is active, as mostly indicated by pain, either early in the case or as a relapse, and if fever is present or paralysis threatens, absolute rest, giving immobility to the diseased bone, and relieving it from the superincumbent body-weight, is essential. This is best attained by the supine position on a hard mattress, and, where feasible, this plan should be adopted. If a child, he can be removed, mattress and all, into the open air, and as much change given as possible, but the same posture must be rigidly maintained. In this stage, blisters over the seat of pain are valuable; they quickly relieve the pain and, presumably, inflammation; two or three in succession must be used. Where there is local heat, with hyperæsthesia, leeches are preferable; setons used to be employed, but their annoyance is disproportionate to their benefit. When acute symptoms are not present, and especially with older patients who cannot be carried into the open air, or with those who are unable to obtain the necessary nursing, mechanical appliances are to be used; with these the patient can move about, and the general health improves thereby. Yet there is no appliance that can give the physiological rest that bed does, hence all appliances are useless whilst lying down; but to keep up the health and spirits requires more nursing attention than can usually be afforded, so mechanical support is employed in most cases. The instrument best adapted to the purpose is *Sayre's plaster-of-Paris jacket*. It is a rigid corset, moulded to the extended portion of the trunk, closely fitting, firmly grasping the pelvis, and reaching breast-high. It acts as an all-round support, and if applied during extension, it keeps off the weight of the upper part of the body from the disease, and holds the trunk straight, simply because any endeavour of the trunk again to 'telescope,' when the patient stands, thus necessitating a proportionate increase of breadth, is prevented by the rigid jacket, in which there is no room for the latter to take place.

Method of Application.—A tight-fitting, specially-woven, merino, sleeveless vest (but any merino vest will do if without buttons), and fastened by its two tags over the shoulders, is put on; its lower edge—which must reach the trochanter at least—is attached to a petticoat or towel wrapped round the legs; it is thus held down, and strained tightly to fit. Between it and the belly, and reaching down from the ensiform cartilage, is placed a flat bedroom towel, folded as when clean; this is the 'dinner-pad,' and it allows room for distension of the abdomen. The pad is not necessary in children who have prominent bellies, but is generally requisite in older patients; the towel is large enough for an adult, in others, a folded napkin is sufficient. If too large, the pad, when removed, leaves too much room, and the jacket may slip round and be useless. Small pads to protect the breasts are used in female patients. The patient is now suspended by two padded straps under the arms, and a collar which supports the chin and occiput, all being attached to a steel cross-bar, which can be raised or lowered by pulleys attached to a tripod or the ceiling. The patient is then gently raised on to tiptoe, or else right off the ground, the guide being pain. If in pain before, such extension only should be used as to make the patient easier; if not, then the extension may be carried out to the full, or short of producing any feeling of strain in the back. If pain be the guide as to the degree of extension, there is no risk of doing harm. Manifestly the degree to which extension may be carried depends upon the stage of the disease and the patient's weight.

All bosses or bony prominences, especially the anterior iliac spines, are now protected with pledgets of wool laid on *outside* the vest; if not so protected, sores from rubbing may result. The bandages are then applied. They are strips of the coarsest muslin (crinoline) 4½ yards long and 4 inches wide, previously prepared by being thickly dusted with *freshly-made* plaster of Paris before being rolled up. To moisten them they must be stood on end, two or three at a time, in a depth of water sufficient to cover them; when bubbles cease to rise they are ready to be applied. The first bandage is commenced round the hips, three-quarters of an inch below the anterior iliac spines, and holds in position the wool-pads that have been applied; after being firmly applied round the pelvis, it is carried obliquely upwards over the trunk, until it and the following bandages are equally distributed between the hips and chest. The lowest limit of the jacket is three-quarters of an inch below the iliac spines; the upper lies easily under the armpits, and should not make the patient high-shouldered. During the application an assistant keeps smoothing the bandages, and adapts them when requisite; turns are to be avoided as far as possible, nor should the bandages be drawn tightly, since they shrink on drying. The number of bandages varies from two to seven or eight. Children of ten years of age require three or four. With good plaster the jacket will have set before the patient is taken from the swing; but if the patient cannot remain the requisite time, he must be lifted down and laid on a mattress on his side until the jacket is set, and be then removed to bed, rolled up in a blanket. He should not, if possible, be allowed to walk until the following day. The dinner- and breast-pads are now drawn out; the woollen pledgets remain. If requisite, the jacket can be trimmed with shears or a knife; if it does not extend below the iliac spines it must be removed and a new one put on; a short jacket cannot be satisfactorily lengthened; when resting above the iliac spines it quickly rubs the skin into sores. Any jacket can be applied within five minutes.

With such a jacket the patient may go about; it will last six to twelve weeks, or longer, according to the progress of the disease and rapidity of growth. To remove it, it must be sawn up the middle with a tenon saw. The new jacket should be applied within twenty-four hours, the patient resting meanwhile. Some dispense with extension, but it ensures the jacket being applied when the chest is in the position of full inspiration, and relieves the diseased bones from downward pressure. There are two modifications in the application of the jacket.

Hammock method (Davy).—A piece of canvas wide enough just to meet round the patient, and twice his height, is suspended horizontally, hammock-fashion. In this the patient, wearing a merino vest, is laid face downwards, apertures being cut for the face and arms, so that the latter hang freely down through the canvas. Moistened plaster bandages are now applied round the body over the canvas, and the patient is then left till the jacket is set; the hammock is then taken down, and the ends cut away, top and bottom, to the level of the jacket; so the patient wears a layer of canvas in addition to his vest.

Recumbent method (Walker). — The same plaster bandages are used, but are moistened with gum and water; they are now cut in lengths exceeding the circumference of the patient's body by four inches; each length is laid flat on a table, one below the other, and overlapping for half its breadth; this is continued till a stratum of bandage equal in length to the vertical measurement of the trunk is completed. A second similar layer is now laid over this, strips of paper being placed at the edges to show the separation between the two layers. The patient is now laid on his back on the bandages, and the various strips are wrapped round him in order, and then left till the plaster has set.

The writer recommends and employs Sayre's original plan, as he fails to find any advantage in the modifications described. No rule can be laid down as to the length of time for the jacket treatment; it depends entirely upon the rate of repair. When all subjective signs have disappeared the after-treatment is begun: this mainly consists in substituting for the entire jacket one that is laced on, and so can be occasionally removed, whilst its not fitting so closely enables the cure to be tested.

Either the plaster jacket may be cut up and laced on, or, what is better, a felt jacket is put on. The 'poroplastic felt' usually employed is first roughly cut to the patient's figure, then steamed in an oven till soft, and then applied over a merino jacket; it sets when cold, and has then the requisite fastenings added. It is in this stage a good material to employ, but it cannot be so accurately applied as the plaster, and, being cut up, it gives less support; hence it is not advised in the earlier stages of the disease.

If there is a discharging lumbar sinus, a movable jacket, if any, must be used throughout. Windows cut in the plaster jacket do not answer.

In atlanto-axoid or occipito-atlantoid disease, as long as there are any subjective symptoms or dyspnœa, the supine position, with a small pillow under the nape, is the only safe one (Hilton). Sandbags on either side will keep the head from rotating. After probably two or three months the patient may get up, with a mechanical support. This may be either a leather or felt corset, bearing a stiff padded collar at the end of a steel rod, to support the head and prevent its rotating, or an adaptation of the plaster jacket. This consists of an ordinary Sayre's jacket, which forms the *point d'appui* of strips of plaster bandage, the centres of which are successively placed on the forehead, and the ends carried on each side over the ears, thence below the occiput, and finally across the scapulæ to beneath the axillæ, and there finished off; thus a rigid support to the head is provided (Furneaux Jordan).

In cervical disease below the axis, and in cervico-dorsal disease, the mechanical support may be the same, but Sayre's '*jury mast*' is better, as it permits rotation, and substitutes an elastic pull on the head for the stiff push up from below. It consists of a fishhook-shaped steel spring, which is attached below to a plaster jacket in the middle of the back, by being interwoven in the bandages as they are put on; the hooked part, passing up behind, arches over the head and carries a collar which supports the occiput and chin. The degree of extension exercised by the spring is regulated by straps to the collar. The upper part of the apparatus unscrews at the upper edge of the jacket, so as to be removed when the patient is in bed. A similar arrangement may be also attached to a movable (e.g. felt) jacket, though the plaster jacket is better for children.

Besides abscess, the special complication of spinal caries is paralysis. This, if due to pus pressure, must be treated by treating the abscess (*see* Psoas Abscess); but if due to inflammation of the cord or membrane, it is to be treated with iodide of potassium in 5-gr. doses, and the local use of counter-irritants; absolute rest being imposed.

The general medical treatment of caries is tonic. The writer prefers Syrupus ferri iodidi, or Ferri pot. tart., with Ol. morrhuæ in cold weather. Dialysed iron is not advised. The food and hygienic conditions must be the best obtainable.

(*b*) In treating angular curvature, it is presumed that all active disease has ceased, the deformity alone remaining. Extension and mechanical support are indicated—the former to expand the chest and relieve the compressed abdominal and thoracic viscera, the latter to maintain the gain by extension. In young subjects, who are still growing, the writer has seen the most marked improvement by the full use of the plaster jacket as above described; the boss, it is true, does not markedly diminish, but the total gain is great in a more erect posture and expanded chest. Where growth has ceased, the instruments mentioned under after-treatment above give enough support to make the patient useful in life; or one of the now old-fashioned 'spinals' (steel crutches arising from a leather and steel pelvic girdle) can be used; its only recommendation is that it lasts longer than felt. Of course many a 'hunchback' goes about without any mechanical aid whatever.

C. Hilton Golding-Bird.

CARIES OF THE TEETH.—As a result of original faulty development or of unfavourable subsequent conditions, the teeth are liable to a destructive process which consists in their decalcification and the disintegration of the organic matrix. It is, in the main, a chemical process, proceeding from without inwards; the theory which regards it as analogous to inflammatory softening of bones being untenable, because it occurs in dead equally with living teeth. During pregnancy, and after certain diseases, notably typhoid fever, the secretions of the mouth are in a state leading to wholesale destruction of the teeth, the destructive agents being probably acids generated by fermentations occurring in the mouth. Nooks and crannies, and the necks of teeth, where they are in close contact with the edge of the gums, are its chosen sites.

It therefore can best be combated by the most scrupulous cleanliness, by brushing the teeth after every meal, and by using alkaline washes copiously, a good formula being carbolic acid combined with a considerable excess of carbonate of soda or of liquor potassæ, and suitably diluted.

Bacteria are abundantly found in carious cavities, and penetrate the dentine to a considerable depth, but the precise share which they take is still *sub judice*; want of cleanliness offers them the most favourable opportunity for multiplication.

Of course all cavities as they arise should be at once filled; in health an annual careful inspection will obviate mischief proceeding to a disastrous extent before it is dealt with; but in cases where destruction is very rife, the teeth should be seen to twice, or even thrice a year, till the period of rapid decay has gone by. It may almost be said that by the time the patient has become aware of the decay the most favourable time for dealing with it by stopping has already gone by.

Left to itself, caries proceeds to the exposure and ultimate inflammation and death of the pulp, then to alveolar abscess. In very exposed positions it sometimes comes to a spontaneous cure, the softened tissue getting worn away and the surface attaining a high polish; this result may in suitable cases be artificially brought about.

Charles Tomes.

CAROTID ARTERIES, Aneurism of the.—*Common Carotid.*—Aneurism of this arterial trunk, particularly when of traumatic origin, may be regarded as a rare affection. The spontaneous variety occurs much less frequently than femoral and popliteal aneurisms of like origin, about as often as subclavian aneurism, and with greater frequency than aneurism of the axillary artery. It has been asserted that carotid aneurism is met with occasionally in young subjects; but in one only, of fifteen cases collected by Mr. R. W. Parker of spontaneous aneurism in persons under twenty years of age, was the common carotid the affected vessel. The proportion of male to female subjects is certainly much smaller in a large series of cases of carotid aneurism than in those of aneurism of any other large artery. Whilst, in all other forms of external aneurism taken together, one female is affected to eight males, in carotid aneurism the numbers of each sex, according to Crisp, are almost equal. Any portion of the common carotid as it courses in the neck may be the seat of aneurism; but the most frequent locality of the affection is at or near the bifurcation. The vessel on the right side is sometimes affected with well-marked though not very progressive dilatation just above its origin at the root of the neck. Aneurismal dilatation of the intra-thoracic portion of the left carotid must be very rare. The right side of the neck is much more frequently the seat of carotid aneurism than the left side.

Carotid aneurism in most instances presents the ordinary objective signs of aneurism of any other large artery situated near the surface of the body. The tumour pulsates very forcibly, and is more or less ovoid in form. It usually increases very slowly in size, and in some cases seems to remain stationary for a time, although it undergoes spontaneous cure very rarely, and ultimately, if left to itself, causes death by rupture, either externally or into the digestive or respiratory tract. The effects produced by the gradual expansion of the aneurismal sac are very varied and of a serious character, in consequence of pressure on important structures in the neck and of disturbance of the cerebral circulation. Most of these symptoms, however, are common to carotid aneurism and to any other deep-seated cervical tumour. Pressure on the laryngeal nerves or directly on the larynx or trachea may cause hoarseness, very troublesome cough, attacks of dyspnœa and spasm of the larynx. There is often more or less difficulty in deglutition, and sometimes—though this is a symptom more frequently met with in aneurism of the internal carotid—the pharynx is occupied by a prominent and distinctly pulsating tumour. The usual cerebral symptoms are headache, occasional giddiness and syncope, and loud subjective ringing or buzzing sounds. The patient complains at times of neuralgic pains on the corresponding side of the head and also on the surface of the neck. Pressure of the aneurism on the sympathetic may cause contraction of the pupil on the same side, and there is often some visual disturbance.

The diagnosis of carotid aneurism may be attended with great and, indeed, insuperable difficulty, especially in a case of pulsating tumour at the root of the neck, which might be due to aneurism of the subclavian, of the innominate, of the vertebral, or of the arch of the aorta. It is necessary in instances of this kind to study carefully the form, situation, and relations of the tumour, the direction in which its bruit is chiefly propagated, and the condition of the circulation in the head, the upper part of the neck, and the upper extremity on the corresponding side. No very positive results, however, can always be obtained by such investigation, since a swelling of like form, and pressure-effects of like nature and intensity to those of carotid aneurism, may, under certain conditions, exist with aneurism of either of the other arteries.

The morbid conditions by which an aneurism on any part of the carotid artery may be simulated are: glandular enlargement and suppuration; deep-seated suppuration of simple inflammatory origin; a new-growth, whether solid or cystic; a vascular tumour or an aneurismal varix; simple or pulsating bronchocele; and a pulsating malignant tumour. The chief points to be observed in establishing the diagnosis are, the shape of the swelling, its condition on proximal or distal compression of the carotid, its relation to and extent of connection with this vessel, the character of the pulsatile expansion, the intensity of the bruit, and the range of vertical movement of the swelling during deglutition.

The results of proximal ligature of the common carotid in the treatment of aneurism of this vessel have not been very satisfactory. Since 1805, when the operation was first performed by Sir A. Cooper, this plan of treatment has been repeatedly tried, and lengthy tables of such cases have been compiled by Pilz and Lefort. Of 47 cases collected by the latter surgeon 21 were fatal, whilst in 2 the operation was followed by relapse, and in some of the remaining cases reported as cured, the results, it is held, were doubtful. The most frequent causes of this tendency to failure of proximal ligature of the common carotid are inflammation of the sac, resulting in suppuration and hæmorrhage, serious cerebral symptoms, and hæmorrhage from the seat of ligature. Under the most favourable circumstances the operation is attended with much risk, and the records of the most successful cases show that recovery is seldom attained without the occurrence of some serious complication.

The results of distal ligature of the common carotid are also unfavourable. The operation, Lefort states, is almost always followed by diminution in the size of the aneurismal tumour, but, as with proximal ligature, there is much risk of subsequent suppuration and rupture of the sac, and also of cerebral mischief. Most of the few recorded cases, however, of distal ligature for carotid aneurism are probably very doubtful, as decided aneurismal dilatation, affecting only the root of the carotid, is not often met with, and its diagnosis must be attended with much difficulty.

The old method of opening the sac and applying a double ligature to the affected artery has been applied with success in cases of traumatic aneurism of the carotid by the second Hey, by Syme, and, more recently, by Frothingham, of Michigan. In 1880 Mr. Henry Morris, in some comments on a case of spontaneous aneurism of the external carotid, reported to the Royal Medical and Chirurgical Society, suggested that it would be best in carotid aneurisms near the bifurcation of the common trunk to ligature simultaneously the common carotid and such branches of the external carotid (facial, superior thyroid, and lingual) as are easily accessible.

Notwithstanding the difficulties in applying and keeping up pressure in the neck, compression, both digital and instrumental, below the tumour, has hitherto been attended with much success in some few cases of carotid aneurism. Mr. Holmes, who has collected seven cases, in two only of which this treatment failed, holds 'that there are forms of carotid aneurism easily curable by compression, and that compression of the carotid artery, though difficult and painful at first, may often be rendered successful by perseverance both on the part of the surgeon and the patient.' It has been proved, also, that a carotid aneurism at the root of the neck may be cured by distal pressure.

In a case of small carotid aneurism, if indirect compression fail after a fair trial, it may be found advisable to try direct compression before any cutting operation be performed. Of this method, however, very little is known beyond a successful case recorded in 1867 by Ciniselli, of Cremona.

Arterio-venous aneurism of the carotid artery and jugular vein has been met with in some few instances. This condition, which almost always, if not always, presents the form of aneurismal varix, is commonly the result of a sword injury. The symptoms are usually well-marked, and resemble those of a similar lesion to other large vessels, but are seldom of such severity as to justify any operative treatment.

External Carotid.—Aneurism of this vessel is usually of the traumatic variety, and implicates one or more of the branches. It presents no special characters. There must necessarily be some difficulty in determining the origin of an aneurismal tumour in this region; but the diagnosis of an aneurism of the external from one of the internal carotid may be assisted by observations of the state of the temporal pulse, and probably, also—as in a case recorded by Mr. Christopher Heath—by the existence of unilateral atrophy of the tongue.

Internal Carotid.— Aneurism of the extra-cranial portion of this vessel, like aneurism of the common carotid, may give rise to cerebral disturbances, but its most marked symptom is a pulsating tumour in the pharynx.

The treatment in cases of aneurism of the secondary carotid vessels should consist, at first, in a careful and persevering attempt at proximal compression, and subsequently, if this fail, in ligature of the common carotid; or, in the case of the external carotid, near its origin, ligature of some of the branches of this vessel together with that of the main trunk, as advised by Mr. Morris. W. Johnson Smith.

CAROTID ARTERY, The Common.

Course. — From the upper part of the sterno-clavicular articulations both arteries ascend on the side of the trachea and œsophagus as high as the upper border of the thyroid cartilage. The left artery comes from the aortic arch close to the left of the innominate; the right results from the division of the innominate. The lower part of the left artery is surgically unimportant. The vessels are practically alike anatomically in the neck.

Whatever the position of the head, a line from the sterno-clavicular articulation to the lobule of the ear marks the course, as high as the upper border of the thyroid cartilage, where the artery ends. For descriptive purposes, it is divided into two parts by the crossing of the anterior belly of the omo-hyoid muscle. This muscle crosses on a level with the cricoid cartilage.

The common carotid artery *above* the omo-hyoid lies in what is known as the superior carotid triangle, bounded by the omo-hyoid below, the digastric and stylo-hyoid above, and the sterno-mastoid behind. The superficial coverings are similar to those over the lower part of the artery. The sterno-mastoid overlaps it; the descendens noni is usually on the sheath, but sometimes within; and the superior thyroid vein, with frequently the lingual and facial veins, crosses its upper end. *Behind* are the vertebræ covered by the longus colli and the rectus capitis anticus major, also the sympathetic cord; *externally*, the internal jugular vein and vagus nerve; *internally*, the larynx and pharynx, covered over by the inferior constrictor muscle. The superior thyroid artery passes down on the inner side of the vessel.

Ligation. — Place the patient on his back, with the shoulders raised, and the face turned to the opposite side. Make an incision, three inches long, from the level of the upper border of the thyroid cartilage downwards in the guiding line, or *vice versâ*; cut through the cutaneous structures, raise the deep fascia carefully—on a director is the best plan—and open it. Now flex the head slightly, to relax the sterno-mastoid, so that it can be pulled outwards. According to where it is wished to apply the ligature, the omo-hyoid muscle is pulled down or not; it is best to do so, and to tie the artery opposite the crico-thyroid membrane. Pick up and incise the common sheath on the inner side, avoiding the veins crossing its upper end. Open the immediate sheath, and pass the needle from the vein, avoiding the internal jugular vein externally, the pneumogastric behind, the superior thyroid artery internally, and the descendens noni nerve in front.

Below the omo-hyoid muscle the coverings are—the skin; superficial fascia having in it, the platysma, the anterior jugular vein, and the descending branch of the transverse cervical nerve; the deep fascia. The sterno-mastoid muscle overlaps it; the sterno-hyoid and sterno-thyroid muscles cover it and cross it; the descendens noni nerve lies on these muscles.

Behind are the transverse processes of the seventh, sixth, and fifth cervical vertebræ, covered by the longus colli muscle. *Internally*, the trachea. *Externally*, the internal jugular vein, and the pneumogastric nerve. The internal jugular vein on both sides tends to the right, hence it departs from the right artery below, but overlaps the left artery. The vessel consequently is more easily reached on the right side.

Ligation. — Make an incision in the guiding line from the sterno-clavicular articulation to the level of the cricoid cartilage. Cut through the cutaneous coverings described, so as to expose the inner border of the sterno-mastoid; now bend the head slightly forwards, and pull—outwards the sterno-mastoid, inwards the sterno-hyoid and sterno-thyroid muscles, upwards the omo-hyoid and the structures associated with it. Open the common vascular sheath, pull outwards the internal jugular vein and the pneumogastric nerve, and inwards the descendens noni; open the immediate sheath, and pass the needle from the vein inwards, keeping close to the vessel.

James Cantlie.

CAROTID ARTERY, The External.

Course. — From the bifurcation of the common carotid at the upper border of the thyroid cartilage, the artery passes upwards to just behind the neck of the condyle of the lower jaw, where it divides.

The coverings are:—skin; superficial fascia, with the great auricular nerve and the external jugular vein; the platysma and the deep fascia. When the deep fascia is opened, it is seen that part of the artery below is in the superior carotid triangle, and that part of the artery above is in the parotid gland; the separation being marked by the crossing of the posterior belly of the digastric and the stylo-hyoid muscles over the artery. In the superior carotid triangle, the artery is crossed by the hypoglossal nerve, and the facial, lingual, and superior thyroid veins; in the parotid gland, the facial nerve and the external jugular vein are superficial to it. Beneath, i.e. internal to the artery, is the pharynx below, with the superior laryngeal nerve crossing to reach the larynx; whilst higher up, between the internal and external carotid arteries are the styloid process, the stylo-pharyngeus muscle, the glosso-pharyngeal nerve, and a piece of the parotid gland. Externally is the internal jugular vein; the internal carotid is seen on the outer side for almost one inch of its course, when it disappears underneath.

Ligation.—Place the patient as for the common carotid operation. Make an incision from just behind the angle of the jaw, downwards along the line of the artery, to just below the upper border of the thyroid cartilage. Divide the cutaneous structures, advisedly using a director for the deep fascia. Draw aside the veins crossing the artery if possible; if not, tie each in two places, and cut between. Pull the digastric and stylo-hyoid muscles and the hypoglossal nerve upwards, the sterno-mastoid outwards. Open the sheath, and pass the needle from without—i.e. from between the artery and the internal jugular vein, with the internal carotid artery externally. The ligature is usually passed immediately above the origin of the superior thyroid artery. James Cantlie.

CAROTID ARTERY, The External, Wounds of branches of the.—The violence of all bleeding from the throat and neck, the suddenness of its occurrence, and the rapidity with which it proves fatal, render the question of the treatment of the following accidents of grave interest to the surgeon :—

1. Punctured wounds about the angle of the jaw or through the mouth. 2. Hæmorrhage after injury to the tonsils. 3. Hæmorrhage from cancer, or from the sloughing of the throat in scarlet fever or diphtheria. 4. Secondary hæmorrhage after wounds or operations.

In some of these cases the careful and accurate adjustment of pressure has occasionally succeeded, while in others cold, astringents, or the actual cautery has been employed with success. In one or two instances the ingenuity of the surgeon has suggested a remedy, as in a case of secondary hæmorrhage after operation for cleft palate, where the bleeding was permanently arrested by a wooden plug in the posterior palatine canal. However successful these palliative measures may occasionally prove, there will remain a certain proportion of cases in which their use is impracticable, or has been employed in vain. If there were a probability of finding the bleeding vessel by enlarging the wound this might be done; but in many instances such an operation would be anatomically impossible. In these circumstances, ligature of the main vessel in continuity has to be resorted to, as the only practicable means of stopping the bleeding.

The common carotid artery has been the vessel usually selected. The writer, however, considers that the external carotid is the better artery to tie, and has fully described the reason for this preference in a paper published in the *Medico-Chirurgical Transactions*, lxi.

Ligature of the common carotid for hæmorrhage is an operation of extreme danger to life, having a death-rate of more than 50 per cent., a large proportion of the fatal cases either dying from brain-symptoms, or a recurrence of hæmorrhage from the original wound. The brain-symptoms are the result of cutting off the blood-supply through the internal carotid, while the recurrence of hæmorrhage from the wound is due to the freedom of the anastomosing circulation. If hæmorrhage continues after deligation of the common trunk, the blood finds its way to the wound from one of the following sources: 1. As a regurgitant stream down the internal carotid. 2. By the communications of the superior with the inferior thyroid. 3. By branches anastomosing across the middle line. By ligature of the external carotid between the thyroid and lingual branches all risk of brain-symptoms is obviated, while the chance of recurrent hæmorrhage is diminished, inasmuch as the communications by the internal carotid and superior thyroid are cut off. The fact of the free anastomoses between the thyroids was markedly illustrated in a case of Guthrie's, in which the external carotid artery was wounded. Here the common carotid artery was tied, but it failed to arrest the bleeding. A ligature was then placed upon the external carotid above the wound, but blood still poured out. The external carotid was then again tied just above the superior thyroid, and the bleeding at once ceased.

An objection might naturally be raised to placing a ligature on the external rather than on the common carotid, on the ground that the surgeon assumes that it is a branch of the former that is wounded, and that, should the bleeding vessel prove to be the internal carotid, an operation worse than useless would have been performed. The answer to this is, that in cases where the common carotid artery had been tied for hæmorrhage, and in which post-mortem examinations were subsequently obtained, it was extremely rarely found that the original wound had been one of the internal carotid—a circumstance to be explained by the fact that a wound of so important a vessel will generally prove fatal in a few minutes, thus affording no opportunity for any surgical interference. In the great majority of cases the bleeding vessel proved to have been one of the numerous branches of the external carotid, and could have been controlled by ligature of that vessel.

The same incision that is employed for ligature of the common carotid above the omohyoid would expose the external branch, which can be traced up from the bifurcation.

HARRISON CRIPPS.

CARPAL BONES, Dislocation of the. TRANSVERSE OR MIDCARPAL DISLOCATION of the hand, as a result of which the second row of carpal bones is separated from the first, only occurs as the effect of great violence, and is very rare. Malgaigne mentions two cases—one, *forwards* and compound, caused by machinery; the other (Maisonneuve's) *backwards*, caused by a fall from a height. In this case the hand was shortened and the fingers flexed; there was a prominence behind below the level of the styloid processes; in front another, with a depression below, *vis-à-vis le pli transversal du poignet*. Reduction has been found difficult or impossible during life, and easy after death. Both these cases died from other injuries. More recently Richmond has described a case in this country of midcarpal dislocation of the hand forwards. A man was drawn up by the strap of a machine nine or ten feet, and fell on his hand. The first row of carpal bones, with the radius and ulna, projected behind, and the second row, with the metacarpal bones, formed a prominence at the base of the hand in front.

Dislocation of any bone of the carpus alone is a rare accident, and generally the result of extreme violence. Of the first row there are instances of separate dislocation of the scaphoid, semilunar, and pisiform bones.

DISLOCATION OF THE PISIFORM BONE occasionally occurs as the result of forcible action of the flexor carpi ulnaris. Gras, Fergusson, and Erichsen have recorded cases produced in the act of lifting heavy weights. The bone is to be felt displaced upwards to the extent of about an inch. The treatment is to flex the hand on the forearm and the forearm on the arm, in order to relax the flexor muscles; to retain the hand in position by means of a curved dorsal splint, and to fix the bone by a pad and strapping.

DISLOCATION OF THE SEMILUNAR occurs more frequently than any other bone of the first row, and is often compound. It may be dislocated *forwards* or *backwards*. The forward dislocation is caused by a fall from a height with the hand extended, and the bone has on several occasions been driven completely through the skin in front of the wrist. This occurred in both hands of one case, the bones from which are preserved in the museum of St. George's Hospital. The effect of its displacement forward beneath the tendons may be to cause flexion of the middle and ring fingers, as in a case recorded by Cameron. Dislocation backward is caused by a fall on the back of the hand. In an instance observed by Erichsen, the bone projected behind, and could be reduced by pressure, but started up again upon flexion of the hand on the wrist.

The treatment, if reduction be effected, will be to retain the palm of the hand on a splint, with a pad over the bone, for two or three weeks. When the dislocation is compound, it is probably advisable to remove the bone at once; if simple and irreducible, it may be excised antiseptically. But without these precautions, considering the relation of the bone to the wrist and great carpal joints, as well as to the tendon-sheaths, an operation is scarcely to be recommended. A compound case operated upon, and reported during the present year by Buchanan, was followed by amputation of the hand; but excision was not performed till the fifth day, and not till after cellulitis had commenced.

DISLOCATION OF THE SCAPHOID.—Astley Cooper relates two cases of this injury: one a compound case caused by machinery, the other a simple dislocation backwards, together with a portion of the radius obliquely fractured into the joint, caused by a fall on the back of the hand. Malgaigne is inclined to throw doubt on the latter case.

DISLOCATION OF THE OS MAGNUM.—Dislocation of the head of the os magnum backwards appears to be the most frequent of the isolated displacements of the carpal bones. It is much more common in women than in men, and Malgaigne classes it as pathological rather than traumatic. It has been caused by falls on the back of the hand, and by muscular contraction during the throes of labour. A rounded projection is seen, situated above and opposite to the base of the metacarpal bone of the middle finger, and a depression close to the base of this bone. In a case related by Cooper, the forefinger was abducted and could not be made to approach the middle until after the dislocation had been reduced. Reduction is effected by pulling on the first and second fingers, and at the same time pressing upon the displaced bone. There is great tendency to reluxation on strongly flexing the hand, to prevent which, a palmar splint, with a pad over the bone behind, should be worn for two or three weeks.

R. Clement Lucas.

CARPUS, Dislocation of the. *See* Wrist-joint, Dislocation of the.

CARR'S SPLINT. for Colles' fracture, consists of a strip of wood about 2 inches wide and 11 inches long, having an irregularly convex surface which is adapted to the shape of the lower end of the radius, and has an obliquely-placed cross-piece, 4 inches long and 1 inch in diameter, attached to its distal end. The splint is applied to the anterior aspect of the forearm, so that the cross-bar lies opposite the metacarpo-phalangeal joints when the hand is adducted. A light dorsal splint may also be applied, but it is not necessary.

Bilton Pollard.

CARTE'S COMPRESSOR. *See* Tourniquets.

CARTILAGE, Articular. *See* Articular Cartilage.

CARTILAGES, Aural. *See* Ear, External.

CASTRATION.—Preparatory to the operation, the pubes and scrotum should be carefully shaved and thoroughly cleansed. For the latter purpose, carbolic lotion, 5 p.c., may be used; but as the thin skin of this region may be irritated by this lotion, corrosive sublimate solution 1–500, or the solution of sulphurous acid B.P., may be substituted for it. Before commencing the operation, a careful examination for hernia should be made, and if present, its contents should be reduced and kept up by an assistant's finger placed over the abdominal ring. The patient being fully anæsthetised, the surgeon should grasp the back of the testicle in his left hand, so as to stretch its coverings over the front, and should then make an incision from the external abdominal ring to the bottom of the scrotum, and quickly cut through all the layers of fascia and muscle until the outer surface of the tunica vaginalis is reached. With a few touches of the knife, the testicle, in its serous covering, is severed from the scrotal tissues; the union between the two is most firm at the lower end of the scrotum. At this stage it is well to place pressure-forceps on all bleeding vessels in the scrotum, as oftentimes the hæmorrhage from this source is profuse. The surgeon should then carefully examine the cord to determine at what part to sever it, and he should proceed to transfix it, about half an inch above this point, with an aneurism needle armed with a double thread; and should tie it tightly in two halves, and then cut it across. The best material to use for this ligature is silk which has been soaked for some time in carbolic lotion, 5 per cent., or stout chromic catgut.

When the stump of the cord has been examined and found to be quite dry, and the surgeon is satisfied that his ligatures are secure, their ends should be cut off short, and the cord will retract into the inguinal canal. The forceps should then be taken off the scrotal vessels one by one, and those that are bleeding should be twisted or tied with fine catgut. After cleansing the wound with corrosive sublimate solution 1–1,000, a drainage-tube should be laid along it and brought out at its lower end, and the edges of the skin approximated by carbolised silk sutures. Owing to the contraction of the dartos, the skin is inverted, and this, unless corrected, delays the perfect healing of the wound. It may be overcome by making a very close continuous suture of the skin with very fine catgut in addition to the deep interrupted sutures. The whole operation may be conducted aseptically, and dressed accordingly. A very good form of dressing is to sprinkle finely-powdered iodoform over the line of incision, and to apply a thick mass of iodoform cotton-wool over the scrotum and pubes—the penis being brought out through it—and fasten it in position with a firm and carefully applied bandage. This dressing need not be disturbed for two days, when, if the tube be dry, it should be removed, the dressing renewed, and left undisturbed for several days, unless pyrexia, or pain, or some other disturbance, necessitate the examination of the wound.

Certain other details may be mentioned. If the testicle to be excised be adherent to the skin, that portion of the scrotal coverings should be removed with the organ by means of two elliptical incisions. Where the surgeon is in any doubt as to the nature of the tumour he is operating for, he should open the tunica vaginalis and explore it—even cutting into the testicle itself if necessary—before detaching it from the scrotum. Owing to the extreme difficulty of diagnosing some cases of hæmatocele, it is a good rule to tap every scrotal tumour before excising it, or, still better, to cut into the tunica vaginalis before detaching it from the scrotum. When there is a large collection of fluid in the tunica vaginalis, it is an advantage to tap the sac before the operation, or to puncture it before dissecting it away. When the case is complicated with inguinal hernia on the same side, the surgeon should at the same time attempt the radical cure of this affection, by dissecting up the sac, stitching it together at the ring, removing the part beyond, and drawing together the pillars of the ring, if that aperture be large. When the cord is thickened high up, it may be necessary to slit up, on a director, the aponeurosis of the external oblique muscle where it covers the inguinal canal, and to ligature the cord close to the internal ring.

There are several other ways of treating the cord, but if the ligatures are tied tightly, the above is the best. Should hæmorrhage occur from the cord—primary or secondary—the inguinal canal must be laid open and the bleeding vessel tied. Where the gland to be removed lies in the groin, the parts covering it must be divided with a vertical incision, and the organ turned out of its bed, and the cord tied as above. As this condition is very often combined with hernia, great care must be taken to seek and, if found, to close any peritoneal prolongation or pouch.

On a few occasions a testicle, retained in the iliac fossa, has been removed on account of cancerous disease. This may be done either by laparotomy, the incision being made in the median line, or by an incision, similar to that for ligature of the external iliac artery, the parts being divided down to the subperitoneal fat, and the peritoneum stripped off the face of the tumour.

A. Pearce Gould.

CATARACT is opacity of the crystalline lens. *See* Crystalline Lens. It occurs in many forms, partial and complete, and is met with at all periods of life, but is more frequent in the old and in the young than in the middle-aged.

Causes and Pathology.—The lens is, by development, a cuticular structure, and is formed of successive layers of fibres derived from the epithelial cells which line its capsule. As in the cuticle, the older layers are firmer, drier, and more closely compacted than the younger; but, unlike what happens in the cuticle, they are not cast off at a free surface, but are constantly surrounded and driven inwards towards the centre by those more newly formed. Unless morbid processes intervene, the addition of fresh fibres at the periphery, and the progressive hardening of the older ones towards the centre, go on throughout the whole period of life, and as a consequence the volume of the lens continually increases, at the rate of about 1·5 cub. mm. each year. At the same time the refractive power undergoes a gradual change, and the fibres, colourless in early life, assume a yellowish tinge, but there is no loss of transparency. The following figures indicate the average weight, volume, and diameter of the lens at the ages of twenty-five and sixty-five respectively; they were obtained by the examination of more than twenty lenses in each decade of life. Weight, 174 and 240 milligrammes; volume, 163 and 225 cub. millimetres; transverse diameter 8·67 and 9·65 millimetres. The average specific gravity is about 1,070, and is not essentially different at different ages (*Trans. Ophth. Soc.* vol. iii. p. 79). The lens, having no direct vascular relations, depends for its nutrient supply on fluid secreted by the ciliary processes, which enters it chiefly, if not entirely, at its periphery, i.e. at the zone corresponding with the apices of the processes and Petit's canal. The causes of cataract are all those conditions which interfere with this normal growth and nutrition.

Classified according to cause, cataract is of three chief kinds:—(*a*) *Primary*, i.e. arising independently of discoverable disease in other parts of the eye. This group includes the great majority of the cases of cataract other than traumatic, which call for surgical treatment, namely all cases of ordinary senile cataract, and most of the varieties met with in infancy and childhood. (*b*) *Traumatic*, i.e. due to mechanical injury of the lens. (*c*) *Secondary*, i.e. resulting from obvious disease in other parts of the eye.

(*a*) *Primary Cataract.*—The nutrition of the lens is sometimes arrested during fœtal life. When this happens, the last-formed fibres, or sometimes the whole of those already formed, shrivel and degenerate and lose their transparency. If, after a while, the normal process is re-established, layers of healthy fibres are laid down upon the damaged ones, and growth continues. A congenital cataract is the result, the lens presenting on examination after birth either an opaque nucleus surrounded by transparent layers, or simply a layer of opaque fibres enclosing a transparent nucleus, and itself enclosed by a transparent cortex. Or the opacity may be spindle-shaped, extending from the anterior to the posterior pole, and associated in some instances with the nuclear or lamellar forms above described. Such spindle-shaped opacities date probably from a very early period in the development of the lens; the opaque substance being adherent to the capsule, is stretched out more and more as the new fibres are laid down, and forms a permanent obstacle to their union in the axial line. Or, again, if the shock to the nutrition of the lens is extreme, a restitution of the process of growth may never take place, and at birth the lens may be opaque throughout, or may be represented merely by a small mass of degenerated fibres, enclosed within a shrivelled capsule. The causes of these intra-uterine disasters are not accurately known; they certainly include mechanical and nervous shocks to the mother, and probably some constitutional diseases productive of lowered vitality in the fœtus. Malformation of the lens at birth is sometimes a part of a general malformation of the eyeball.

Disturbance of the nutrition of the lens seems sometimes to occur rather suddenly during infancy and childhood, and to leave a lamellar opacity similar in kind to that already described as arising *in utero*. It is probable, however, that some cataracts which appear to be acquired in infancy are really of intra-uterine origin, the original disturbance damaging the fibres, then in process of formation, to an extent which is not sufficient to render them opaque, but which leaves them liable to further damage by comparatively slight causes, mechanical or other, after birth. A case is on record in which an infant's lenses, previously examined with the ophthalmoscope and found transparent, became opaque immediately after a convulsive seizure. There is, however, no reason to deny that nutritive disturbances may cause a lamellar opacity during extra-uterine growth in the same way as at an earlier stage. The amount of transparent matter between the opaque lamella and the capsule should be some guide as to the time which has elapsed since the initial disturbance. Children presenting lamellar or other varieties of primary cataract are very generally delicate in appearance and of nervous temperament. A history of convulsions in infancy is frequently forthcoming on inquiry, though this connection is not an invariable one. Signs of rickets are present in many cases, and in a very large majority the teeth show peculiar defects consisting in an abruptly limited deficiency or absence of enamel on the upper part of the tooth. The teeth affected are the first molars, canines, and incisors, of the permanent set. As the crystalline lens and the teeth are, alike, epithelial structures and develop at the same period, it is reasonable to suppose that the defects in question are due to a common cause affecting the nutrition of both.

During the middle period of life, primary cataract arises much less frequently than at either extreme, and when it does occur it is in most cases due to one specific cause—diabetes. In persons suffering from diabetes, cataract may occur at any age; it has been met with so early as the twelfth year. The amount of sugar in the urine is usually large, and the nutrition of the patient greatly impaired. When this is not the case, the patient is usually advanced in years. Sugar is present in these cases in the fluids of the eye, and has many times been found in the lens itself; but the precise way in which it induces the changes in the lens-fibres is still uncertain. The volume of the lens appears to be increased by excessive imbibition of fluid, a large portion of which enters, not in the normal direction, but by diffusion through the anterior and posterior capsule.

The third or last period of life, during which senile degeneration of many kinds is common, yields a large majority of all cases of primary cataract. The whitening and thinning of the hair, and the shrivelling of the skin, common in advanced life, find their physiological analogue in an increasing tendency to shrinkage and sclerosis of the lens-fibres; and this sclerosis, if it pass beyond a certain point, involves separation and disintegration of the fibres. Beyond the age of seventy, some slight opacification near to the equator of the lens is rather the rule than the exception. The writer's investigations on the growth of the crystalline lens (*loc. cit.*), besides establishing the fact of a continuous enlargement throughout life, have shown that previous to the formation of actual opacity in the lens there is usually a diminution in the rate of growth. The advancing sclerosis and shrinkage cause a separation of the fibre-layers just where the capsule and subjacent fibres are most affected by the traction of the suspensory ligament, viz. at the equator, and this separation is usually the first step in the formation of senile cataract. By it a clear line of demarcation is established between the nucleus, or sclerosed portion, and the cortex, or non-sclerosed portion; the spaces caused by the separation of the layers fill with fluid; abnormal diffusion-processes ensue, which lead, more or less rapidly, to further splitting of the layers and breaking up of the individual fibres into a molecular mass, until the whole substance of the lens is more or less opacified, and sometimes, in the last stage, fatty and calcareous degenerations occur. Simultaneously with these retrograde changes, a rapid and abnormal production of new cells usually takes place in the capsular epithelium, due probably to a lessening of the intra-capsular pressure by which the cell-proliferation is ordinarily held in check.

Though the tissue-changes which constitute cataract are thus accurately known, the causes which determine their occurrence—earlier in some persons, later in others—are still uncertain. Albuminuria, and atheroma of the carotids have been supposed to play an important part in the causation of senile cataract, but careful inquiry shows this conjecture to have small foundation. The essential change is a failure of nutrition in the epithelial cells and fibres of the lens; it is likely that vascular degeneration in the region from which the nutrition proceeds, is the underlying cause. In a certain sense, senile cataract is hardly to be considered a morbid condition, but rather one of senile decay occurring prematurely, and one to which all eyes would come did their owners live long enough. The peculiar condition of the lens known as black cataract will be described later in discussing the symptoms of the various forms.

(*b*) *Traumatic Cataract* is due, in the great majority of cases, to perforating wounds of the globe which involve the lens-capsule. Contusions without perforation occasionally cause rupture of the capsule and thus lead to cataract; and in rare cases the lens-substance opacifies as the immediate result of an injury which neither perforates the tunics nor causes any break of continuity in the capsule. Injuries which involve damage to the uveal tract may, of course, impair the nutrition of the lens to such an extent as to lead, in course of time, to its degeneration; in such cases the cataract should be classed rather as secondary than as traumatic. When the capsule is wounded, the fibres in the immediate neighbourhood of the opening rapidly imbibe fluid from the aqueous or vitreous chamber, swell up and thereby become opaque, and finally disintegrate. This occurs more or less rapidly according to the size of the wound and the age of the person. In the young eye absorption of the entire lens-substance may take place. It is not very unusual, however, for the disturbance caused by a small wound to remain for a long time limited to the part injured; for example, a minute fragment of metal, or other foreign body, becoming embedded in the lens, may leave only a small localised opacity, connected with the capsular wound by a fine opaque line, marking the path along which it travelled. In such cases the opening in the capsule doubtless closes at once and completely. Such closure is promoted by adhesion of the iris at the point of injury, but may occur quite independently of it. The most frequent causes of traumatic cataract are punctures produced by scissors, forks, needles, awls, thorns, sharp fragments of metal, &c.: when wounds of larger size involve the lens, the injury is frequently so extensive as to cause total destruction of the eye.

(*c*) *Secondary Cataract.*—Many diseases of the eye, and especially those which involve the uveal tract, and which impair the secretory function of the ciliary processes, are apt secondarily to induce degeneration of the lens. Thus cataract is common as a late result of cyclitis, irido-cyclitis, choroiditis, retinitis pigmentosa, absolute glaucoma, retinal detachment, and intra-ocular tumour. In many of these conditions the lens acquires adhesions with false membranes and vascular tissues, and imbibes fluids in directions in which, normally, no fluid permeates the capsule. A special tendency to proliferation of the capsular epithelium, due probably to this morbid nutrient supply, is characteristic of many kinds of secondary cataract. The clinical importance of secondary cataract is usually not great, for at the stage in which it occurs the eye is often blind, or nearly so, from the original disease, but there is one variety in which this is not the case, and which, therefore, deserves special notice: anterior polar cataract. In some forms of secondary cataract—namely, in those which depend upon choroidal disease—the opacity begins at the posterior pole of the lens.

Anterior Polar Cataract may arise either before or after birth; in either case the cause is of the same kind—namely, contact of the lens-capsule in the pupillary area with an inflamed cornea, or with products of inflammation in the anterior chamber. Morbid fluid, and in some cases pus-cells, traverse the exposed portion of the capsule and excite proliferation and disturbance in the subjacent epithelium and fibres. The capsule is eroded and thinned, and often somewhat elevated by the projecting mass of débris beneath it, forming a small prominent opacity, known as a pyramidal cataract; or the opacity may take the form of a circular group of dots corresponding with the margin of the pupil. The process is essentially the same, whether the resulting opacity is punctiform, flake-like, or pyramidal. A perforating ulcer, often the result of purulent ophthalmia immediately after birth, is the usual cause of anterior polar cataract, but perforation is not necessary to its production. During fœtal life, in which no anterior chamber exists, any inflammatory affection of the cornea, probably, may suffice to affect the capsular epithelium, and, as a matter of fact, in many cases of congenital anterior polar cataract no trace of a corneal cicatrix is discoverable. This form of cataract usually remains unaltered throughout life.

In an advanced stage secondary cataracts are apt to undergo calcification, especially if they are in abnormal and close relation with vascular membranes. The chalky deposit is found first in the layer of new tissue formed by the proliferation of the capsular epithelium, and in the pseudo-epithelium which forms within the posterior capsule. Later it invades the entire lens-substance, progressing from periphery to centre. Calcareous deposits of smaller size are found in primary senile cataracts in an advanced stage, in the form of thin films of strongly refracting granules near to the capsule. Total calcification of the lens is a matter of months, if not of years, for the intra-ocular fluid is poor in inorganic constituents, and the interchange of fluids is extremely slow in the degenerating lens. A mass of true bone may be formed in the position normally occupied by the lens, and may assume the contour of the lens, the process being an ossification of morbid tissue which has taken the place of the lens, and been moulded into its shape by pathological formations surrounding it; but ossification of the lens-substance itself, while still enclosed in its unbroken capsule, never occurs.

Symptoms and Diagnosis of Cataract. The *subjective symptoms* consist only of the visual troubles which naturally arise from a want of transparency in the lens. As a means of diagnosis they are no longer of much moment, for since the introduction of the ophthalmoscope the presence of cataract in any stage is determined by objective methods only; but it is important, none the less, to know the kind of complaints which are made by persons suffering from cataract in various stages, and in all cases in which operative measures have to be considered, a careful testing of the subjective condition is necessary in order to ascertain the presence or absence of retinal or other complications which would detract from the result of the operation or render it useless.

The extent to which vision is affected depends upon the amount of the opacity and upon its relation to the pupillary area. A few small opaque striæ at the margin of the lens, such as usually constitute the beginning of senile cataract, and, indeed, may remain unaltered for many years, are not incompatible with perfectly sharp vision. In like manner the small opaque white dot seated in the centre of the pupil, known as anterior polar cataract, causes little or no impairment of vision, though the eyes in which it is found often have defective sight by reason of the corneal cicatrices, which commonly accompany it and are due to the same original cause. Apart from these two forms, cataract always causes more or less impairment of vision. Simultaneously with its commencement there is often a change of refraction in the lens in the direction of myopia. *See* Refraction, Errors of. The patient states that the convex glasses which used to clear distant objects no longer give any assistance, indeed that he sees more clearly without them. Hypermetropia, formerly present, has disappeared. In many cases eyes previously emmetropic become myopic. At the same time, or very soon afterwards, the acuity of vision begins to fail, and continues to do so from month to month; reading has to be given up; after a while the patient can no longer safely walk alone; and finally only the power of discerning light from darkness remains. Unless cataract be complicated with disease of other parts of the eye perception of light is never lost, and the patient can indicate with considerable accuracy the position and movements of a luminous object, such as a candle, held before his face. In the earlier stages of the disease bright light—direct sunlight, for example—usually distresses the patient and increases his difficulty in seeing. This is due partly to the dazzling which is produced when the opaque particles in the lens are strongly illuminated by rays of light impinging directly upon them—a phenomenon easily realised when one sees how much more obscure a dusty window-pane becomes where it catches the sunlight than where it is shaded by the window-frame—and partly to contraction of the pupil. The latter is of course most detrimental when the opacity is seated chiefly in the central region of the lens. In such cases vision is often distinctly better towards evening, or when the patient turns his back to the window and shades his eyes with his hand, by reason of the dilatation of the pupil which occurs under those circumstances.

In young children who are the subjects of lamellar cataract, the impairment of vision is sometimes so moderate in degree that it attracts no attention until, with the first attempts at schooling, it appears that the child is unable to learn his letters without great difficulty. In cases where the opaque lamina is very thin, the child may even learn to read and write without much difficulty, and go through a large part of his school life without coming under medical examination with regard to his sight. From his habit of bringing his book very near to his eyes such a child is often supposed to be myopic rather than the subject of cataract, and, as a fact, myopia is not infrequently present in addition to the lental opacity. Though the periphery of the lens is clear in these cases, the clear zone usually lies quite outside the area of the pupil, so that it is *through* the cataract, and not round it, that the child sees. In the denser forms of congenital and juvenile cataract the impairment of vision may be quite equal to that caused by the densest senile cataract, and it is often the essential cause of another peculiar symptom—viz. nystagmus, or continuous oscillations of the eyeballs.

The *objective symptoms* of cataract are the visible changes in the lens. In an advanced stage cataract usually manifests itself readily to ordinary daylight inspection, the pupil presenting, instead of its normal blackness, a grey, yellowish-grey, brownish-grey, or even solid white, appearance, which tells at once of opacity in the region of the lens. Simple inspection is, however, insufficient for a safe diagnosis. Those who venture by its means alone to pronounce an opinion as to the presence or absence of cataract will inevitably sometimes fall into serious error. The normal sclerosis of the lens-fibres increases their power of reflecting light, and at sixty or seventy years of age the normal lens, instead of being completely invisible, as in early life, gives to the pupil a distinctly greyish look, indistinguishable in some cases, on ordinary inspection, from commencing cataract. Under certain circumstances, notably in glaucoma, this reflex is still further increased, and sometimes to such an extent that a lens which is in reality quite transparent may simulate a cataract almost ready for extraction. This resemblance has often led to unfortunate mistakes; persons suffering from glaucoma have been told that their failure of vision was due to cataract, and have, on this account, postponed the question of an operation until their eyesight was nearly, if not entirely, extinguished—that is to say, until the glaucoma had passed into an incurable stage. Hence the importance of a precise investigation of every case.

The condition of the crystalline lens is investigated by two methods: firstly, by *focal illumination*, a method which strongly illuminates any portions of the lens-substance which are opaque, and, when the opacities are few and small as compared with the transparent matter, causes them to stand out against the latter as against a dark background; secondly, by the help of the *ophthalmoscope*. If any considerable portion of the lens remains transparent, the light from the mirror passes through it to the fundus of the eye, and this, being situated in the focus of the lens, is more strongly illuminated than the lens itself, and affords a bright background, against which opacities in the latter stand out as dark markings. When the opacity is general it, of course, intercepts the light of the mirror, and prevents the illumination of the fundus; the opaque parts then appear illuminated as in the focal method.

For focal illumination the patient is placed at a distance of about two feet from a lamp, and in such a position that the light falls upon his face somewhat from one side, rather than directly from in front. The observer holds a lens of two or three inches focus between his finger and thumb, as he would hold a burning glass, and placing it in a line between the lamp and the eye, and at about its own focal distance from the latter, focusses the light upon the pupil. Any opacities lying near to the anterior surface of the lens, and within the area of the pupil, are by this means at once brought into view, and by varying the position of the patient's eye in relation to the light, and looking into the pupil in different directions, a large part of the lens may be brought under examination. To examine the posterior pole of the lens, the eye must be directed nearly towards the lamp, so that the light enters the pupil nearly in the perpendicular direction, and the observer must look into it as nearly as possible in the same direction. The peripheral parts of the lens can only be completely examined after dilatation of the pupil by atropine, or some other mydriatic.

In examining with the ophthalmoscope, the observer looks obliquely into the eye from different points of view rather than from directly in front. By this means the extreme contraction of the pupil which ensues when the patient is allowed to look towards the mirror is avoided, and as much as possible of the periphery of the lens is brought under examination. The light employed should be of only moderate intensity, or the fainter forms of opacity are likely to be overlooked. The eye of the observer should be focussed for the patient's lens rather than for the fundus, and to this end it is useful to place behind the mirror a convex lens of sixteen or twenty inches focus, and to approach to a point somewhat within this distance of the eye; or a convex lens may be held between the mirror and the patient's eye, or even placed close in front of the latter in the ordinary trial spectacle-frame. The depth at which an opacity lies in the substance of the lens is estimated most readily by the focal method, but it may also be determined by means of the ophthalmoscope. An opacity occupying the centre of the anterior capsule is seen as a dark, opaque spot in the centre of the illuminated pupil, and, since it is practically in the plane of the iris, does not move from this central position, however obliquely the observer may look at it. A similar opacity at the centre of the posterior capsule, on the other hand, is only to be seen in the centre of the pupil when the observer's eye stands exactly in line with the axis of the lens. If from this position he moves slightly to either side, the opacity appears to move towards the corresponding side of the pupil. The rate of this apparent movement, or, in other words, the readiness with which the opacity disappears behind the margin of the pupil, is a guide to its depth behind the plane of the iris. On the same principle, opacities which lie behind the lens, namely, in the vitreous body, are distinguished from lental opacities by the greater rapidity of their apparent movements. Vitreous opacities, moreover, often show more or less independent movement of their own, called forth by movements of the eye, but continuing after these have ceased.

Opacity of the cornea occasionally simulates cataract to a superficial observer; the distinction is made at once by focal illumination. A filmy opacity in the anterior stratum of the vitreous—that is, in actual contact with the posterior lens-capsule—is at times hardly distinguishable from an opacity within the capsule, and, indeed, the distinction is not very important, for cataract appearing in that form is usually secondary to changes in the vitreous fluid. A dense opacity in the region of the vitreous humour, such as is produced by glioma (*see* OPTIC NERVE and RETINA), and by those infiltrations of the vitreous which resemble glioma (*see* VITREOUS), sometimes presents an appearance which may be mistaken for cataract unless a careful focal examination be made with especial regard to the depth of the opaque body behind the iris. Again, small masses of pigment remaining adherent to the anterior lens-capsule after the subsidence of an iritis, are sometimes not to be distinguished with the ophthalmoscope alone from opacities beneath the capsule, or in the anterior layers of the lens-substance; their position, however, will usually suggest an iritic origin, and a careful focal examination will set the matter at rest. There are cases, however, in which an inflammatory exudation in the anterior chamber not only leaves opaque deposits on the outer surface of the capsule, but, by osmosis through it, sets up changes in the capsular epithelium, which lead to punctiform opacity within it.

Since the introduction of the ophthalmoscope the so-called catoptric test, by which the transparency of the lens is investigated by observing the images of a candle reflected from its anterior and posterior surfaces, has almost passed out of use; but it may still be sometimes employed with advantage, notably when the presence of a black cataract—a variety which neither focal illumination nor the ophthalmoscope can reveal with certainty—is suspected.

The earliest objective sign of *senile cataract* is usually the presence of a few linear or wedge-shaped opacities, beginning apparently near to the equator of the lens, and pointing towards its axis. They are at first to be seen only by looking very obliquely into the eye, and may be quite beyond the reach of inspection until the pupil is dilated with atropine. They indicate a splitting up of the fibre-layers at the junction of the sclerosed portion or nucleus, and the non-sclerosed portion or cortex, and may be found, on careful examination, to embrace the margin of the nucleus, passing inwards both over its anterior and posterior surfaces. Prior to the appearance of actual opacity visible under focal illumination, the ophthalmoscope will sometimes detect the presence of radiating streaks or lines, which shift their position or disappear as the direction of the light is varied; these indicate the formation of minute interstices filled with clear fluid, and are usually near precursors of actual opacity. In the course of months or years the marginal striæ increase in number and size, and invade the area of the pupil. They coalesce to form sector-shaped and flake-like patches of opacity, and they extend towards the capsule. Gradually the whole pupillary area becomes opaque, and the red glare of the fundus is no longer visible with the ophthalmoscope. For a while longer the laminar structure of the lens may be indicated by glistening sectors or radiating lines, and then these also disappear, and the opacity assumes a more uniform, greyish, or yellowish-white look, and involves the whole of the cortical substance quite up to the capsule. At this stage the cataract is, from the surgical point of view, *mature*. The special signs by which maturity is estimated will be described farther on.

The appearances which cataracts present in a still later stage correspond with the further degeneration of the opaque cortex. More or less shrinking usually occurs, which gives to the capsule a shrivelled look; spots and patches of a denser white make their appearance, and the bulk of the cataract is noticeably diminished. Less commonly the capsule remains distended by fluid imbibed from without, and the disintegrated fibres break down into a semi-fluid pulp. Occasionally the liquefaction of the cortex is so complete that the nucleus, which always retains its consistency, floats freely about in it, when the head is bent forwards falling against the anterior capsule so as to become visible, disappearing when the head is thrown back. This condition is known as 'Morgagnian' cataract. The brilliant white spots and patches which make their appearance on the surface of over-mature cataracts are due to changes in the capsular epithelium, and constitute what is called capsular cataract. The opacity differs from that of the lens-substance, not only in being denser and whiter, but in being devoid of stellate marking, and in being limited to an area not exceeding that of the moderately dilated pupil. A final change occasionally to be witnessed in over-mature cataract is the spontaneous loosening of the lens from its attachments. In consequence, probably, of the shrinking of the lens, the suspensory ligament gives way at some part of the circle, and the shrivelled lens is drawn towards the opposite side, leaving a clear space, through which, with the help of a cataract-glass, the patient may enjoy useful vision, or the lens may fall back into the vitreous chamber and leave the pupil entirely free. This spontaneous cure of the blindness is a rare event, and occurs for the most part only after the cataract has been complete for many years, and in persons whose nutrition is greatly impaired.

The foregoing description of the development of the opacity in senile cataract is applicable to very many cases, but not to all. In some the opacity, instead of advancing from the periphery towards the pupillary area, makes its appearance in the central part first, and thence gradually extends outwards. This does not necessarily imply that the degeneration begins actually in the nucleus; in some cases, certainly, it is the cortical layers immediately overlying the surface of the nucleus which suffer first, and the cataract is really cortical throughout, as in the form already described. But in others the morbid process actually begins in the nucleus, and the cortical layers suffer later, the rate of progress being for the most part extremely slow. This is a true nuclear cataract. It appears, in some respects, to stand midway between the ordinary cortical cataract of the old, and the general soft cataract of the young. The opacity has a diffuse, cloudy look, and is devoid of the radiate marks which are common in cortical cataract, though there is sometimes in the cortex a Y-shaped line of opacity, causing a well-marked tripartite division. In colour it is milky or yellowish. In the nucleus the opacity may develop quickly, but its invasion of the cortex is very slow, and the patient must wait through a long period of partial blindness before the cataract is sufficiently ripe for extraction. These are the cases in which vision is decidedly improved by a moderate dilatation of the pupil, either as the result of shading the eyes, or by the use of atropine.

Diabetic Cataract presents no specially distinctive appearances. Its characters vary, like those of other forms, with the age of the subjects. Thus, in young people, the whole lens—there being no hardened nucleus—becomes opaque throughout, while in old people the cortex and nucleus are differentiated, as in ordinary senile cataract. Both lenses are commonly affected together, or very nearly together. In all cases of double cataract in young or middle-aged adults the presence of diabetes should be suspected.

Black Cataract is a term applied to a peculiar and rare condition of the lens met with in the second half of life. To ordinary inspection the pupil appears black; focal illumination fails to reveal any decided opacity; but no reflex from the fundus is obtainable with the ophthalmoscope. Under the catoptric test the image of the candle which should be produced by reflection from the posterior surface of the lens is wanting, the lens is of a deep brown colour throughout, and though it presents none of the ordinary signs of opacity is practically impenetrable by light. Such lenses are in reality not cataractous at all, but owe their opacity to a great excess of the brown coloration which is present to some extent in all healthy lenses in later life. It has been asserted that the coloration is due to an infiltration of the lens-substance with hæmatin; but lately a careful spectroscopic examination has proved that it is not derived directly from any of the blood-pigments; the colouring matter belongs to the same class of pigments as melanin, and presents analogies with the colouring matters of hair and feathers; it is, in short, a cuticular pigment, a further point of analogy between the lens and the skin. (*Trans. Ophth. Soc.*, vol. ii. p. 10.)

Traumatic Cataract varies greatly in its course and symptoms according to the nature and extent of the injury and the age of the patient. Under focal illumination the opacity can generally be traced to a wound in the lens-capsule. From this it spreads, sometimes in the course of a few hours, sometimes much less rapidly, to the whole of the lens-substance, which swells considerably as it becomes opaque. In the soft lens of childhood the spread of the opacity and the swelling are much more rapid than in the hard lens of advanced life. A wound of some size in the anterior capsule of a child's lens is followed, in a few hours, by the escape of a considerable mass of grey lens-matter into the anterior chamber, and not only the extruded portion but the whole of the remainder, with the exception of a few films adhering closely to the capsule, may in the course of a few weeks undergo spontaneous solution and removal, so that a black pupil is restored. A smaller wound will lead more slowly to the development of a complete cataract, and the process of absorption may come to a standstill, so that surgical interference is required before disintegration and removal of the opaque matter occur. Very small wounds, as has been already stated, sometimes close at once, and cause nothing more than a small limited opacity in their immediate neighbourhood. Small fragments of metal or other foreign substance entering the lens may lead rapidly to total cataract, or may for a considerable time remain the centre of a small opacity which spreads no further. Or, passing completely through the lens from front to back, they may leave only an opaque line in their path. When the anterior and posterior capsule are both wounded, the opacity spreads more from the anterior than from the posterior wound, the vitreous humour taking less effect upon the exposed fibres than the aqueous. A fragment of iron, or other metal liable to undergo chemical changes, may in course of time cause discoloration of the opaque lens-substance in which it is embedded; such discoloration should therefore excite suspicion of a foreign body being present. Other things being equal, a wound of a senile lens is a more serious injury than a wound of a young lens: for in advanced life, the lens, being of large size, is in closer relations with the surrounding structures, and is therefore, when it swells, more likely to cause difficulties with the iris and ciliary processes than the smaller lens of a child or young adult. In the uncommon cases of traumatic cataract in which the capsule is not ruptured, the opacity generally makes its appearance first at the anterior or posterior cortex, and advances much less rapidly than when the capsule is opened.

Lamellar Cataract is less easily made out by ordinary inspection of the eye than many other forms. With an undilated pupil it is often quite invisible until focal illumination or the ophthalmoscope is used, Looking straight into the eye with the ophthalmoscope, the observer notes that the reflex from the fundus is imperfect, but the cause of the dimness is not revealed until he looks obliquely behind one or other border of the pupil. Then the periphery of the lens is seen to be quite clear and to stand out sharply against the central clouded area. The opacity appears to become more dense towards its outer margin, where it is limited by a well-defined dark outline; this however, is more apparent than real, and is due to the fact that at the margin the opaque lamina presents itself edgeways, while in the central area it lies perpendicular to the line of view. The apparent increase of density towards the margin of the opacity distinguishes the lamellar from the solid nuclear form of cataract. In the latter the density is of course greatest in the axis of the lens, where the largest amount of opaque substance lies. Under focal illumination, with dilated pupil, a lamellar cataract presents the appearance of a bright semi-transparent filmy vesicle or shell, lying without visible attachments in the midst of a transparent medium. The amount of opaque matter varies from an almost invisible film in some cases to an almost solid-looking mass in others. The initial disturbance of the fibres is very probably in most cases an intra-uterine event, but a decided and sometimes sudden increase of the opacity is not infrequent during infancy or early childhood. Beyond this time of life an extension of the opacity is the exception, rather than the rule. From the margin of the opaque area radiating stripes or lines may sometimes be seen, extending outwards into the clear portion, and an increase of these at any time would indicate the probability of a general opacification; as a rule they are stationary. An inner shell of opacity may sometimes be seen within the outer one, the two being quite concentric and separated from each other by a layer of transparent substance; an instance of three distinct layers of opacity is on record. In nearly all cases lamellar cataract affects both eyes. The total nuclear, membranous, and other congenital varieties of cataract do not require detailed description; the appearances which they present may be best interpreted by considering the manner in which the fœtal lens is built up, and the effects which would result from disturbance of its growth at various periods.

Secondary Cataract may usually be recognised as such without difficulty. In many cases signs of a bygone iritis or iridocyclitis are present, and if the opacity is not sufficient to completely hide the fundus, deeper-seated disease of the uveal tract may be discoverable. The loss of vision is generally greater than can be accounted for by the lental opacity only, and in very many cases amounts to total blindness; the character of the opacity itself is sometimes a sufficient evidence of its being the result of other mischief in the eye. Thus a stellate opacity seated in the posterior cortex of the lens is an almost certain sign of choroidal disease of one kind or another. It is frequently met with in the later stages of retinitis pigmentosa. It is to be distinguished from a rarer form of posterior polar cataract which is congenital, and which probably depends upon an abnormality in the fœtal hyaloid artery. This latter presents the appearance of a solid glistening plaque, and has not the diffuse and radiate character of the choroidal cataract. The radiate opacity is internal to the capsule and follows the anatomical arrangement of the fibres; the plaque is probably external, and owes its glistening look to its being lined, as it were, by the capsule. Anterior polar cataract—a small central opacity immediately beneath and involving the anterior capsule—is, as already stated, an evidence of bygone corneal suppuration. A dense irregular patch may sometimes be seen occupying the centre of the anterior capsule in what looks like an ordinary senile cataract; it tells of morbid secretions in the anterior chamber. Again, the more pronounced degenerative changes to which secondary cataracts are liable often give them a brilliant white or yellow appearance which declares at once that the lental disease is not the primary one.

Maturity.—From the surgical point of view, this is one of the most important questions involved in the examination of a cataract. A cataract is said to be mature when the adhesion of the cortex to the capsule is so far destroyed that the whole of the lens-substance can escape readily when the capsule is opened—in other words, when the cataract will leave its envelope as a ripe nut leaves its shell. To this end the whole cortex, and especially the layers in contact with the capsule, must be involved in the degeneration. Generally speaking, a cataract is not mature until the opacity has come close up to the capsule. In order to estimate maturity, the observer illuminates the eye by the focal method, causing the pencil of light to fall upon it obliquely from one side. If there be a layer of transparent matter between the opaque fibres and the capsule, the edge of the pupil nearest to the light will cast a shadow of crescent form into the substance of the lens, while if the opacity be immediately beneath the capsule, no such shadow will be cast upon it. In the second place he throws light upon the lens with the ophthalmoscope, when, if it be mature, no red glare from the fundus will be obtainable. The rule then is that a mature cataract receives no shadow into its substance on focal illumination, and permits no illumination of the fundus. But the rule is not absolute. There are cataracts which fulfil both these requirements, and yet are immature, and there are mature cataracts which fulfil neither. Thus, in some instances, the soft opaque cortical substance is entirely wanting, or very nearly so, the whole lens consisting apparently of a large brownish-yellow nucleus, which, although sufficiently clouded to destroy useful vision, will still allow some illumination of the fundus, and receive a shadow on focal examination. Such cataracts grow darker in colour with age, but do not become truly opaque. They will often separate readily from the capsule, and are therefore, in a surgical sense, mature. Again there is a form in which the opacity appears first in the nucleus, and invades the cortex very slowly; ultimately a thin subcapsular layer becomes opaque, and then the cataract is ripe for removal, even though the iris may still cast a shadow into it. On the other hand, despite the ordinary signs of maturity, a cataract is not fully ripe if, under focal examination, its surface shows well-marked glittering sectors. These indicate that some thin flakes still remain transparent, and, so long as this is so, a complete separation of the cataract from the capsule cannot be relied on. The glittering appearance is usually not of long duration; the sectors soon break down and then the cataract is mature. (Förster.)

A thorough examination of the condition of the lens can only be made after the pupil has been dilated with atropine, or homatropine, the latter being sometimes preferable because of its more transient action; but, in using either of these drugs in elderly people, it is well to remember that, where any tendency to glaucoma exists, dilatation of the pupil is apt to intensify it. The tension of the eye should therefore be carefully ascertained beforehand. Priestley Smith.

CATARACT, Treatment of.—*Therapeutic Treatment* is powerless to remove an opacity of the lens, and very rarely has any decided effect in delaying its progress. Still, the possibility of doing some good by general treatment should not be entirely lost sight of. Slight opacities of the lens have been known to clear up, and in very many cases they remain stationary for long periods of time; it is, therefore, always right in the early stages of the progressive forms of cataract to inquire as to the habits of life and the constitutional condition of the patient, and to correct any faults, as far as may be possible, in the hope of lessening the tendency to further degenerative changes. Among other alleged remedies electricity has been put forward as a cure for cataract, but no satisfactory evidence of its utility has been given. It is very probable that some of the reported cures by this and other therapeutic measures have been due to the clearing up of cloudy conditions of the vitreous.

Palliative Treatment, which aims not at removing the opacity, but at diminishing its detrimental effect upon the sight, is very useful in certain forms and stages of cataract. Thus, tinted glasses to moderate the light, atropine to enlarge the pupil, iridectomy to uncover a transparent portion of the lens when the opacity is chiefly central, sometimes give much help. Their special application will be discussed in connection with the various forms of cataract. Apart from these palliative measures, the only treatment which is available is an operation for the removal of the opaque lens.

Operative Treatment.—Broadly speaking the operations now employed for the removal of cataract are of three kinds: 1. Those which by admitting the aqueous humour freely into the substance of the lens promote its solution in, and spontaneous removal by, the fluids of the eye. 2. Those by which it is removed piecemeal through a small opening in the wall of the eye. 3. Those by which it is removed more or less unbroken and entire through an opening of larger size. A fourth method, distinct in principle from the foregoing, was formerly much employed, but has now fallen into almost complete disuse—the operation known as couching or reclination, by which the opaque lens was dislocated backwards into the vitreous humour, so as to leave the area of the pupil free. The choice between these several methods in any given case is determined by the consistency of the cataract. From the operative point of view cataracts may be classed as hard or soft. A *soft* cataract is one which is either pulpy throughout, or will become so after the aqueous has been freely admitted into its substance, and which, therefore, can be removed through a small opening. A *hard* cataract is one which, having a firm nucleus, cannot be rendered pulpy throughout, and which therefore demands a much larger opening for its removal from the eye. Whether a cataract is hard or soft depends, not upon the nature of the morbid process, but upon the natural consistency of the healthy lens at the corresponding time of life. With few exceptions, in early life all cataracts are soft, in advanced life all are hard; there is no sharp line separating the one class from the other, the transition is gradual, like the process of sclerosis by which the hardened nucleus is formed. For practical purposes, the age of thirty or thereabouts may be taken as the point that separates the cataract which is soft throughout, from the one in which a firm nucleus must be expected. It is not often that a doubt on the matter arises, for, except as the result of injury, cataract at this time of life is rare.

Before taking each of the chief varieties of cataract in turn, and pointing out how it should be dealt with, it will be well to deal generally with the question of *the use of anæsthetics in cataract operations.* Until lately it has been the custom of many operators to use ether, chloroform, or some other general anæsthetic, in most operations for cataract; others have employed them only for children and for nervous adults, in whom the necessary self-control could not be expected. In addition to the avoidance of pain, anæsthesia confers the advantage of passivity of the eye and eyelids; but it carries with it the drawbacks of nausea and constitutional upset for a time after the operation, and the chance of vomiting, which, in certain cases, may greatly imperil the eye. In operations which do not include a large wound, the risk from the latter cause is slight and need hardly be considered, and the question of an anæsthetic must depend on the amount of pain likely to be given and the steadiness of the patient. In needle operations, which involve only the cornea and lens, the pain is slight; in iridectomy it is more severe. In iridectomy for artificial pupil, in which a wound of the lens would be a serious disaster, the need for passivity is at its greatest. When a large wound is to be made, as in extraction of senile cataract, vomiting involves great risk, and on this account, as well as that the patient may be able to assist the operator by voluntarily directing his eyes in the required direction, some surgeons dispense with anæsthetics almost entirely in the removal of senile cataract. The matter has remained one for individual choice and experience. The writer, having found that the administration of fifteen or twenty grains of chloral-hydrate by the mouth about twenty minutes before ether-inhalation much diminishes the liability to sickness, has used this mode of anæsthesia largely with good results.

Koller's discovery in September, 1884, of the power of cocaine to induce local anæsthesia in the eye, has, in the course of a few months, changed the practice with regard to anæsthetics in ophthalmic operations, all over the world. A few instillations of a four per cent. solution of hydrochlorate of cocaine, render the whole of the conjunctiva and cornea sufficiently anæsthetic for operations which involve these structures only; the iris may be rendered subnormally sensitive by a further instillation after the anterior chamber has been opened; and, with care and a warning to the patient not to flinch at the moment when the iris is seized, operations involving this membrane also may usually be satisfactorily carried out. Hence, nearly all the operative measures which are required in treating cataract may now be undertaken with the help of local anæsthesia only. In cases in which severe congestion and inflammation of the eye are present—as, for example, in some cases of traumatic cataract—the effect of cocaine in lessening sensibility is very slight.

LAMELLAR AND NUCLEAR CATARACT IN YOUNG PEOPLE.—In these forms the opacity is usually non-progressive, and the marginal zone of the lens remains permanently clear. In a few cases of the lamellar variety, vision is sufficiently good for all ordinary purposes, and it is best not to interfere in any way; usually we have to decide between the formation of an artificial pupil by iridectomy, and the removal of the lens by a needle operation. If, after wide dilatation of the pupil by atropine, and the correction of any refractive error, vision still remains very insufficient in both eyes, and if the eye appears to be sound as regards the condition of the retina and in other ways, the removal of the lens is indicated; but if, on the other hand, vision is found under these circumstances to be fairly good, it is better simply to uncover the margin of the lens at one part of the circle by an iridectomy. (For a description of the operation, *see* IRIDECTOMY.) The latter proceeding has several advantages. It is a safe operation, and is very quickly recovered from; it permits of useful vision without the use of spectacles; it spares the accommodative function of the eye; it does not preclude, but rather facilitates, the subsequent removal of the lens, if this should prove necessary. On the other hand, it must be allowed that in a light-coloured iris an artificial pupil is disfiguring, but the wearing of cataract-glasses is hardly less so. Some surgeons remove the lens from one eye, and at the same time iridectomise the other. This practice is decidedly objectionable, for although the aphakial eye may be aided with a glass, the two eyes will not work well together; the patient probably soon lays aside the glass, and learns to depend almost entirely upon the eye which has the artificial pupil, thus proving that an iridectomy in both would have served his purpose better. The position of the *artificial pupil* must correspond with a clear part of the lens-margin, and must be determined by careful examination beforehand with the ophthalmoscope. If possible it should be downwards and inwards.

In cases of lamellar cataract both eyes usually require operation. There is no objection to operating for artificial pupil on both at one time. The only accident which can easily happen, in making an artificial pupil in the cases now under consideration, is wounding the lens. Should it occur, the case must be dealt with as one of ordinary traumatic cataract in a young subject.

Two other methods of making an artificial pupil are occasionally employed—iridodesis and iridotomy. *Iridodesis*, or the entanglement of the iris in the cornea, was recommended by the late Mr. Critchett, but has been abandoned because it may lead to sympathetic ophthalmitis. *Iridotomy*, which signifies the cutting, merely—not the *cutting out*—of iris, is sometimes practised, but is dangerous for zonular cataract; though, as will be seen later, iridotomy is a most valuable operation for opening up the pupil when the lens is absent. *See* below and Iris.

Those cases of lamellar and nuclear cataract, for which an operation for artificial pupil is obviously unsuited, or in which it proves insufficient, must be treated by the needle operation (discision), followed, if necessary, by linear extraction, with or without the help of suction. These methods will be described in connection with the treatment of complete soft cataract—the form of the disease in which they are chiefly employed.

Complete Soft Cataract.—In infancy and childhood an opaque lens may usually be got rid of by one or more simple needle-operations. By this proceeding the anterior capsule is lacerated, and the fibre-layers are more or less broken up and exposed to the action of the aqueous humour. Any portions not previously opaque become so, and the whole lens-substance swells, softens, and gradually dissolves in the fluid which macerates it. The younger the patient, the more rapidly does the process of disintegration go on, and the less danger is there of inflammatory complications on the part of the iris. This is a reason for early operation in cases of congenital cataract. A stronger reason still lies in the fact, that the absence of visual impressions, in very early life, appears to act unfavourably on the development of the brain-centres which control the movements of the eyes. Children blind from birth, or blinded soon after birth, as, for instance, by purulent ophthalmia, frequently present the symptom known as nystagmus—a continual oscillation of the eyes indicative of disordered action in the cerebral centres for ocular movements. A needle operation, if it is required, may properly be undertaken in the third month after birth, before its results are likely to be interfered with by the troubles of dentition. An earlier interference than this is not desirable, for at birth the aqueous humour is scanty, and the anterior chamber extremely shallow.

Needle Operation (*Discision*) *and Solution*.—The pupil must be thoroughly under the influence of atropine. The instruments required are the speculum, the fixing forceps, and a cataract-needle. Some operators prefer, in the absence of an anæsthetic, to fix the lids and globe with the fingers rather than with instruments. The extremity of the needle is flattened and has two cutting edges; in the shaft it is cylindrical and slightly tapered, so that it completely fills the puncture which it makes, and prevents escape of the aqueous. A stop or shoulder on the shaft serves as a guide to the depth to which it enters the eye, and gives it additional strength. The speculum being in place and the globe fixed, the point of the needle is pushed rather obliquely through the cornea in its outer and lower quadrant, at a point about midway between the centre and the margin, and carried to the centre of the pupil; by a few gentle to-and-fro movements it is then made to divide the centre of the capsule with crossed cuts, and to break up the anterior layers of the lens. The needle is then carefully withdrawn, its flattened point coming out in the same plane as it went in. The iris must not be touched with the needle; the aperture made in the capsule must be smaller than the pupil; the lens must not be forcibly or deeply cut into; the movement of the needle must not be such as to drag upon the cornea, but must be made in lever fashion around the corneal puncture as a fixed point. After the operation, the pupil is kept dilated to the utmost by applications of atropine at intervals of not more than three hours; a fold of linen, dipped in cold or iced water, is kept lying across the lids for forty-eight hours, or longer if there is any reaction, and later the eyes are covered with a shade. Exposure to strong light is to be strictly avoided. In very young children any application over the eyelids sometimes causes much fretting, and does more harm than good; the eyes must then be allowed to remain uncovered, and the room darkened.

The result of the operation is that the lens-matter immediately adjacent to the wound in the capsule becomes opaque, if it was not so already, swells, protrudes, more or less, into the anterior chamber, and ultimately shrinks and disappears, the bulk of the lens being thereby reduced. In a few cases a single operation leads to complete solution and removal of the lens. More commonly the needling has to be repeated two, or three, or more, times, at intervals of several weeks. In the later operations, the needle may be used rather more freely than at first, for the lens is smaller, and a sudden and dangerous swelling of its substance is less likely to occur. During the whole period of the treatment, the eye is to be kept thoroughly under atropine and no fresh needling must be undertaken so long as the slightest sign of irritation remains over from the last. In the final stage there sometimes remains an opaque membrane upon which the process of solution takes no further effect. If this cannot be readily divided by the single needle, it is safer to employ two than to drag upon the ciliary processes in the effort to tear it through. One needle is passed through the inner half of the cornea and through the centre of the membrane, the other through the outer half of the cornea and to the same spot in the membrane; then, by approximating the handles, the points are separated, and an aperture is torn in the membrane without any dragging on its ciliary attachments (Bowman). Instead of repeating the needling when the process of solution appears to be at a standstill, it sometimes answers well merely to evacuate the anterior chamber by a small opening in the cornea; the fluid thus drawn off is highly charged with the débris of the lens; it is replaced by a fresh aqueous secretion, and solution begins again.

The needle operation, when properly performed and followed by careful after-treatment, is a safe procedure. The complications which we have to fear are iritis and even irido-cyclitis from irritation of the vascular structures in the neighbourhood of the lens, and increase of tension—secondary glaucoma—caused by the pressure of the swollen lens against these parts and consequent compression of the filtration channels at the angle of the anterior chamber. Slight congestion in the ciliary region without pain is not serious; but if the congestion be considerable, and the colour of the iris altered, a severe iritis is imminent, and must be promptly met by the application of two or three leeches to the temple or lower eyelid, very free instillation of atropine, persistent use of iced compresses, and, if the bowels be inactive, a purge. If the inflammatory symptoms persist, or if the eye become hard, either with or without pain and congestion, relief must be given immediately by removal of the swollen lens-matter by linear extraction or the suction method described below. The tendency to glaucomatous complication increases as the size of the lens increases; it has, therefore, a direct relation to the age of the patient. The needle operation alone is suited chiefly to the complete cataracts of children. In young adults, in whom the process of solution goes on more slowly, and to whom time is of more value, it is usually supplemented by linear extraction or suction. It is not well suited, even in children, to fluid cataracts, nor to those which have tough and thickened capsules.

Linear Extraction.—This operation affects the removal of the softened lens piecemeal through a small straight incision in the cornea. It is applicable to soft cataracts, for which the needle operation proves insufficient; to fluid and other completely softened cataracts, without previous needling; to traumatic cataracts below the age of twenty-five, when the swollen lens-matter sets up inflammation or excess of tension; to lamellar, nuclear, and other partial forms of cataract, after they have been made complete by previous needling. The instruments required are the speculum and fixing-forceps, a keratome, a cystotome, and a curette. Under the same conditions as before with regard to dilatation of the pupil, separation of the lids, and fixation of the globe, the keratome is passed through the cornea at a point 2 or 3 mm. within its outer margin, and carried onwards parallel with the iris until an incision from 4 to 6 mm. in length is effected. It is then slowly withdrawn. If the lens-capsule be not already opened the cystotome is introduced, care being taken not to entangle its point in the iris, and the capsule is lacerated as freely as the size of the pupil will allow; it is then withdrawn with the same precautions as before. Instead of using the cystotome some surgeons open the capsule with the point of the keratome at the moment of completing the incision. If the iris prolapse through the wound, the extruded portion is taken up with iris-forceps and cut off as in an ordinary iridectomy. The curette is then gently pressed upon the outer lip of the wound, so as to make it gape a little, and at the same time slight pressure is made upon the globe with the fixing forceps. A considerable portion, if not the whole, of the lens-substance is by this means evacuated, and the pupil at once assumes a more or less black appearance. In order to effect the removal of any fragments which may remain, the speculum is now removed, the eyelids closed, and a few light rotatory stroking movements made over the cornea by means of a finger on the upper eyelid. Time is given for the anterior chamber to refill with aqueous. On re-opening the wound by pressure with the curette, a further clearance of the pupil will then take place. Pains and time must be devoted to removing in this way all particles of lens-matter which can be got away, but it is not advisable to put instruments of any kind into the anterior chamber for this purpose. It is better to leave some lens-matter in the eye than to irritate it by violence. Fragments which remain behind are usually absorbed. The after-treatment is the same as in the needle operation.

Suction.—This operation differs from the foregoing in the manner of obtaining the escape of the lens-matter. The incision need not be quite so large as in the former case. The instrument through which the soft lens-matter is drawn out of the eye is a smooth round-ended metal canula, mounted either on a small syringe worked on the principle of an aspirator by the hand of the operator (Bowman), or on an india-rubber tube with a mouthpiece, which is held and aspirated with the lips (Teale). The canula is passed into the chamber with its aperture towards the cornea, and gently dipped into the semifluid lens-matter. By very gentle suction this is gradually drawn up into the tube, as much being removed as possible. The nozzle of the instrument must be brought as little as possible into contact with the iris, and must not be passed behind it in search of fragments. The operation gives, in many cases, excellent results; it is followed, however, every now and then by suppuration and loss of the eye. Delicacy of manipulation and absolute purity of the suction instrument are essential to the avoidance of these disasters.

HARD CATARACT.—In the earlier stages of senile cataract palliative measures sometimes give much help. For outdoor use 'globular' spectacles, combining the power which gives the best distant vision with a blue or neutral tint, to lessen the uncomfortable glare caused by bright light, should be ordered. If the opacity in the pupillary area is considerable, while the lens-margin is comparatively clear, a moderate dilatation of the pupil by atropine, such as may be attained by the use of a single drop of a very weak solution once a day, or on alternate days, is likely to give help. A tenth of a grain of the sulphate of atropia to an ounce of distilled water is quite strong enough for such a purpose. The possibility of inducing glaucoma by wide and prolonged dilatation of the pupil must not be forgotten. During the earlier stages of the disease the opportunity should be taken of examining and carefully noting the ophthalmoscopic appearance of the fundus; for there may be changes of importance here, such as patchy atrophy of the choroid, which at a later stage would be undiscoverable, but which would affect the result of an operation. When the opacity becomes general, the maturity, or ripeness, of the cataract is to be carefully estimated according to the tests already given. Complete maturity gives the best prospect of a successful operation, and should usually be waited for. When the cataract in the one eye is well in advance of that in the other, this commonly involves no great hardship, for the one eye is ready before the other has lost all useful sight; but when the opacity is equal in the two eyes, waiting for maturity may mean a long and trying time of partial blindness, during which the patient's means of livelihood may be cut off, and the health and spirits much depressed. In such cases the ripening may sometimes be hastened artificially in a way which will be described further on, and an operation may sometimes be ventured on before complete maturity is attained. If one eye only is affected and the patient is advanced in years, an operation should not, in the writer's opinion, be recommended; if perfectly successful it will rarely enable the two eyes to work well together, the one requiring a cataract-glass, the other none, and it is to be borne in mind that failure of the operation followed by sympathetic mischief in the good eye, though not a likely result, is still a possibility.

Before the removal of a cataract is undertaken, the soundness of the eye in other respects must be carefully tested. Cataract, however dense, never abolishes perception of light. If the retina be healthy, the patient, when placed with his face to the window, will perceive the shadow of a hand passed before his eyes; and in a dark room he will usually be able to indicate the position of a lighted candle, or of an ophthalmoscope throwing light upon the eye at a distance of two or three feet. If all perception of light is wanting, an operation will be useless. A ready response of the pupil to light and to atropine is favourable; a small and rigid pupil, unless it be adherent, indicates degeneration of nerves or of vessels, and a somewhat greater liability to bleeding and to inflammation of the iris. In such cases it is best to prepare for the extraction of the lens by performing an iridectomy some weeks previously. It is never advisable to extract a cataract from both eyes at the same time, for, should both do badly, the disaster is absolute and final, whereas a failure in the case of a single eye not only leaves a second chance still open, but will not improbably suggest some modified proceeding, which will give a better prospect of success for the second eye.

In all cases of cataract the cornea should be carefully examined under focal illumination. A nebula, so slight as easily to escape notice while the opaque lens is behind it, may materially affect the acuity of vision after the operation. It need be no bar to operating, but the patient should be informed beforehand of its presence and of its probable effect on his sight after the cataract is removed. The state of the eyelids and tear-passages must also be noted; a chronic discharge from either, especially if purulent, exposes the eye to a risk of destructive inflammation after operation, and must be remedied beforehand as far as possible. When any complication of this kind persists, in spite of treatment, disinfectants of one kind or other must be assiduously used to the conjunctiva, both before and after the operation. Of the various disinfectants which have been recommended for use in ophthalmic surgery, boracic acid, either in powder or in saturated watery solution, and iodoform as a very fine powder, are among the best. Some authorities, especially among the Germans, advocate a rigid antiseptic treatment in all cases—e.g. washing out the conjunctival sac with carbolic solutions, immersion of all instruments in absolute alcohol, the spray during the operation, medicated dressings of various kinds after it, and so forth; but the evidence advanced in favour of these measures has not been sufficiently strong to lead to their routine adoption in this country. Finally, the bodily health of the patient must be considered before an operation for the extraction of cataract is recommended. Temperate habits, good digestion, and freedom from serious organic disease will strongly favour a good result, but it is not necessary to abstain from operating, even though there be pronounced cardiac or pulmonary mischief, provided the patient have the prospect of some years of life. Diabetes appears to add little, if at all, to the risks of a bad result. Chronic albuminuria, on the other hand, increases the danger very materially. Advanced age is of itself no contra-indication, provided there is no extreme feebleness. Many perfectly successful extractions have been done in persons more than eighty years old.

Operations for Hard Cataract.—A hard cataract can only be removed through an opening of considerable size. The aim of the surgeon is to incise the tunics in a manner which, while it permits the lens to escape readily, offers the best conditions for healing, and the least danger of destructive inflammation. Very many modes of operating, differing more or less as regards the size, the form, and the position of the incision, and the manner of dealing with the iris, have been practised and described. Two distinct types are represented by the operations known as the 'flap extraction' and the 'peripheral linear extraction.' Each of these goes to an extreme in avoiding the drawbacks which belong to the other, and experience has shown that the best operations lie somewhere between the two. The subject will be best explained, therefore, by describing first these two typical, but extreme, modes, and then the modifications which are in more general use.

Flap Extraction.—The incision is made at the margin of the cornea, or just within it, and forms a semicircular flap, either of the upper or the lower half of the cornea. The speculum and fixing-forceps may be used, or, as was formerly always done, the globe and one of the lids may be fixed by the operator's fingers, the other lid by those of his assistant. The triangular knife is entered at, or just within, the outer margin of the cornea, and carried across the anterior chamber in a plane parallel with the iris, until it emerges at a point diametrically opposite to the point of entrance; it is then pushed steadily onwards until, by reason of the increasing width of the blade, it cuts its way out and completes the semicircular flap. The cystotome is then passed into the anterior chamber, and the capsule is opened; the body of the lens, escaping from its sac, then comes forward through the pupil, rotating somewhat upon its transverse axis as it does so, the edge nearest to the wound appearing first, and escapes from the eye. If the escape does not occur spontaneously, it is effected by making slight pressure on the globe.

When the wound heals favourably, and no inflammation follows, the result of extraction by the flap method is more perfect, as regards the appearance of the eye and the condition of the pupil, than can be attained by any other mode of extraction. But there are many dangers, and when the flap extraction was commonly practised failures were more numerous than they are now. The shape of the incision is unfavourable to ready coaptation of its lips, and allows of gaping upon the occurrence of the slightest pressure from within, as during coughing, vomiting, or straining of any kind; the extensive separation of the corneal tissue from its source of nourishment exposes it to great risk of non-union and destruction by suppuration; prolapse, and incarceration of the iris in the wound, occur readily, and may lead to iridocyclitis; the mechanical bruising of the iris during the exit of the cataract is apt to set up inflammation, and to lead to closure of the pupil.

Peripheral Linear Extraction (Von Graefe).—This operation embodies the principles by which the dangers attaching to the foregoing are to be avoided. The incision, instead of being a semicircle, is, as nearly as possible, a straight line, for the more the curvilinear form is got rid of, the less does the wound tend to gape, and the more likely is it to unite smoothly. Instead of being placed wholly in the nonvascular cornea, and cutting off the nutrient supply from one half of this membrane, it lies almost entirely in the sclera, and corresponds to not more than one-third of the circumference of the cornea. The portion of the iris adjacent to the wound is excised; this not only obviates the bruising which occurs when the pupil is entire, but enables the cataract to present more easily in the wound, removes in great part the tendency to prolapse, and lessens the likelihood of the pupil becoming occluded should iritis follow the operation. As will be seen, however, it is not free from special dangers of its own. The instruments required are the stop-speculum and fixing-forceps; a linear knife, 2 mm. broad, about 30 mm. long, and as thin as is consistent with strength; curved iris-forceps; iris-scissors; a cystotome, the best form being that which is bent at an angle so as to clear the brow, the bend being different for right and left eye; and a curette or spatula. There should also be placed ready to the hand a small but stiff pair of scissors, with which to enlarge the wound in case of need; a scoop to remove the lens with, should it fail to present in the ordinary way—the kind known as the vectis (B. Taylor), which is merely a wire loop, being the best, because it occupies the least space inside the eye; and a small, sharp lens-hook, sometimes required for a similar purpose.

The operator stands behind the patient's head, and makes the incision with his right hand for the right eye, with his left hand for the left. The lids being secured in the usual way, the conjunctiva is seized below the lower margin of the cornea, and the globe turned gently downwards far enough to expose the sclera above the cornea. The knife, with its edge turned upwards, is entered in the sclera at a point about 1·5 mm. external to the outer and upper margin of the cornea, and 2 mm. below the level of an imaginary line drawn horizontally through the highest point of the corneal margin. It is directed in the first place, not towards the intended counter-puncture, but towards the centre of the pupil, so as to make the internal dimension of the wound as large as possible. As soon as the point has passed well into the anterior chamber, the direction of the knife is changed, and it is carried across the upper part of the chamber and out through the sclera in such a way as to effect a counter-puncture exactly corresponding in position with the puncture. The edge of the blade is then turned slightly forwards, and gentle sawing movements are made, till it cuts its way out with a minimum amount of force, and without any sudden jerk, exactly at the junction of the cornea and sclera. The conjunctiva, which still remains to be divided, unless the apex of the incision lie just within the visible margin of the cornea, is severed in the form of a small flap by a few more to-and-fro movements of the knife. This completes the first act of the operation. The incision thus made, if measured externally in a straight line, will have a length about equal to the transverse diameter of the cornea; its extremities will lie in the sclera, its middle portion will pass almost entirely through corneal tissue; it will have a minimum amount of curvature, hence its name ‘linear.’ The second act is the iridectomy. If necessary, the fixing-forceps are given to the assistant, who rotates the eye gently downwards, while the operator passes the forceps closed into the chamber, if the iris be not already prolapsed, and seizing the pupillary border of the iris opposite to the centre of the wound, draws it gently out, and cuts it off. Some operators remove the iris-segment by separate snips at the two extremities of the wound; others by a single snip, with the scissor-blades lying parallel with the incision. Seeing that the object is to make a perfectly clean but not a very extensive excision, the single snip, which is quick and easy, is to be preferred; but the blades should lie across and not along the wound.

The third act is the laceration of the capsule. The operator resumes the fixing-forceps, and passes the cystotome into the chamber on the flat, taking care that its blunt side is in advance of the point, lest the latter should become engaged too soon. Arrived at the farther margin of the pupil, he turns the point towards the capsule, and, without sensible pressure upon the latter, crucially divides it as freely as possible. It is important not to make a triangular flap of capsule with its base at the wound, as such a flap would readily prolapse, and, becoming incarcerated at the cicatrix, might be the cause of serious mischief later on. The fourth act is the delivery of the cataract, or of so much of it as remains, for more or less of the softened cortex often escapes immediately after the capsule is opened. Gentle pressure is made immediately below the cornea with the back of the curette, or, if it be preferred, with a tortoiseshell or india-rubber spoon, which should cause the wound to gape a little, and the upper edge of the nucleus to present itself. The pressure is cautiously increased, and as the cataract moves upward, it is followed up by the curette over the surface of the cornea. The moment the largest part of the cataract has passed the opening, the pressure is diminished, and the delivery is completed with the utmost gentleness, the cataract being helped out, if necessary, with a touch of the curette. If it be necessary to retain a hold of the conjunctiva during the delivery of the cataract, the pressure may be made with the fixing-forceps, the curette being used at first upon the upper lip of the wound to make it gape, and then upon the cornea to stroke the cataract out of the eye. Some operators remove the speculum before delivering the lens, and, telling the patient to look towards his feet, make the necessary pressure by a finger on each lid.

The cataract being removed, the eyelids are closed for a few moments so as to rest the eye, and to allow the anterior chamber to refill with aqueous humour. They are then reopened, and the operation is completed by the removal of any cortical fragments which may still be visible in the pupil, and by cleansing the wound of any tags of iris which may be retained in it, and the surface of the eye of blood-films. A few rotatory movements of the finger on the upper lid will tend to bring cortical fragments into the pupil, and then, while the patient looks downwards, these are extruded by an upward stroking movement of the lower lid upon the cornea. Much pains must be bestowed on this cleansing of the pupil, but instruments should not be introduced into the eye. An incarceration of the iris will often disappear under a similar stroking with the lid over the angles of the wound; if not, a fine spatula must be used. Blood-clots should be picked from the conjunctiva with the iris-forceps. A drop of atropine is instilled, and the lids are finally closed. Some surgeons use eserine before the operation, and once or twice after it, with the idea of diminishing the risk of prolapse of the iris; against the advantage so aimed at must be set the fact that eserine increases the bleeding after the iridectomy, and probably the tendency to iritis afterwards. The dressing consists of a soft circular pad of absorbent cotton wool between layers of gauze laid over each eye, and held in place by several turns of a roller bandage made of flannel or some other slightly elastic material, the pressure being light and equable. The patient is instructed to lie in bed, either on his back or turning towards the side not operated on, and to avoid all straining movements. If no severe or lasting pain be complained of, the dressing need not be disturbed for forty-eight hours, and then if there be no swelling of the lids, it is sufficient to place a drop of atropine at the inner canthus, and to bandage as before. If all be well, the patient may sit up for an hour or two on the third day, and gradually resume his usual hours. A daily action of the bowels should be obtained by aperients if necessary. Light must be excluded from both eyes for three or four days, and from the operated eye for at least ten days. A deep shade, and, later, tinted glasses, are substituted for the pad and bandage as the eye gains strength. Spectacles should not, as a rule, be allowed under three months after the operation.

The peripheral linear operation, as above described, obviates the special drawbacks of the old flap, but is apt to err in the opposite direction. The incision, lying as it does almost wholly in the sclera, may easily pass beyond safe limits and create a risk of sympathetic inflammation in the fellow eye. The divided vessels sometimes bleed freely into the anterior chamber. The exposure of the suspensory ligament predisposes to rupture and an escape of vitreous. With regard to details, therefore, the operation is at present modified in a good many different ways, of which the following are the most important.

The incision is now often made exactly at the sclero-corneal margin, and of such extent that its extremities lie 3 mm. below a horizontal line passing through the summit of the cornea. The points for the puncture and counter-puncture in this incision are found by laying the blade of the knife, which is 2 mm. broad, horizontally across the cornea, so that 1 mm. of clear cornea remains exposed above it (De Wecker). This is known as the short, or 3 mm. flap. An iridectomy must be performed, but need not be very extensive. The wound adapts itself well, but it sometimes proves a little smaller than is desirable. To avoid this, the puncture and counter-puncture may, when necessary, lie 1 mm. external to the corneal margin. In another form of incision at present a good deal practised, the puncture and counter-puncture lie in the sclera, while the remainder passes through the cornea at some distance from its edge.

The iridectomy is sometimes performed three weeks or longer before the extraction of the cataract. It is then called *preliminary iridectomy*. An incision not more than 4 or 5 mm. long, made with a keratome, suffices, and the cicatrix resulting from it may be disregarded when the extraction is undertaken. This division of the operation into two parts is probably the safest of all methods. A properly performed preliminary iridectomy is almost absolutely devoid of danger to the eye; should serious reaction occur, the surgeon may feel almost sure that an attempt to extract the cataract at the same time would have destroyed the eye. The extraction is facilitated by the previous iridectomy, for there is no bleeding from the iris, and the risk of employing an assistant to fix the globe in presence of a large incision is done away with, for at no stage is a third hand needed. Against the method may be urged the delay, and the chance of disappointment to the patient at the want of apparent result from the first operation. If the iridectomy be made many months before the extraction, there appears in some cases to be an increased liability to rupture of the suspensory ligament and escape of vitreous. A cataract previously immature will sometimes ripen rapidly after an iridectomy; and, with this end in view, a proceeding known as *artificial ripening* is sometimes practised (Förster). Immediately the iridectomy is completed, and while the anterior chamber is still nearly empty, the cornea is stroked with as much firmness as is judged safe with the smooth knee of a strabismus-hook; by this means the anterior cortex is kneaded, as it were, through the cornea, and its splitting up is expedited. The method is often effectual, but involves a distinct risk of setting up iritis by bruising the iris.

Difficulties, accidents, and complications.—The aperture of the lids is sometimes too small to allow of easy access to the sclero-corneal junction; division of the outer canthus is useful in such cases. Holding the lids away from the globe by means of the speculum, the operator transfixes the tissues with a cataract-knife or bistoury from the conjunctival surface, and bringing the point out through the skin divides them freely; bleeding follows, but soon ceases. The lids can then be opened more widely. If the knife be improperly directed within the anterior chamber and the counterpuncture made in a wrong place, it must be withdrawn until the point is disengaged and a second counterpuncture must be made. Should it be necessary through any carelessness to withdraw the blade entirely, no further incision must be made until the anterior chamber is refilled and the aperture closed. The aqueous may escape and distend the conjunctiva like a bladder the moment the counterpuncture is effected, and the iris may sometimes double itself upon the edge of the knife; these occurrences are not serious, and the incision is to be deliberately completed without regard to them. Downward rotation of the eye must be accomplished with the aid of the patient's own efforts, if he be not anæsthetised—never in opposition to them. Dragging upon the globe, especially after the incision is completed, is almost sure to rupture the zonula.

If, when the cystotome is applied to the capsule, the lens is seen to move as a whole with the pricker, dislocation of the cataract and escape of vitreous are imminent. If the cataract do not at once present, it must be removed by a traction instrument—the vectis or the sharp hook—passed carefully but quickly behind it. When the delivery of the cataract is attempted the wound may prove too small. Undue force is dangerous, and bruising of the lips of the wound is likely to lead to suppuration. It must be lengthened at one end by a careful cut with the scissors. An opaque lens is always, or nearly always, smaller than a healthy lens at the same time of life, otherwise the difficulties of extraction would be greater than they are; but in the period of swelling which sometimes precedes complete maturity, the size is probably not far different from that of the normal lens. The so-called 'black cataract' is an exception to the rule; it is not really a cataract at all, and probably has the full size of the healthy lens. If the anterior chamber fill with blood after the iridectomy, light pressure on the outer lip of the wound will sometimes clear it; if this prove unsuccessful, the operation must be completed in spite of the cataract being hidden.

Escape of vitreous denotes rupture of the zonula or posterior capsule, and of the hyaloid membrane. It may arise from the wound being too peripheral, or from undue pressure on the globe. It is more likely to occur in stout, short-necked persons with turgid veins and prominent eyes, than in thin, hollow-eyed, aged people. Collapse of the cornea, on the completion of the incision, is a sign that the contents of the globe are not driven forwards either by the elastic shrinking of the sclera, or by pressure from without; it may be taken as a sign that escape of the vitreous is not likely to happen. In old people with greatly degenerated vessels, especially in drinkers, we may anticipate an unsound condition of the zonula and vitreous, which will almost inevitably lead to loss of the latter. If vitreous fluid escape before the lens, the danger of losing the latter altogether is great; the cataract must, if possible, be immediately removed by traction, as above explained. An escape of vitreous together with the cataract, or after it, is not necessarily detrimental, unless other harm have been done; but it probably predisposes to deep-seated changes both at the time and later, and should always be avoided if possible. In rare instances immediate and copious bleeding takes place from the deep vessels; the eye is thereby lost, and should be excised as soon as possible.

The pain after the operation is usually not severe; it should subside after a few hours. Severe and increasing pain after the first six or eight hours is a sign that things are going wrong, and the eye must be examined. The complication most to be dreaded is suppurative inflammation, beginning at the wound. If this occur, the lips of the wound will show a yellowish infiltration, and may be coated with shreds of muco-pus; the conjunctiva will be swollen, the aqueous more or less turbid. Unless the suppuration can be immediately checked it is likely to involve the whole of the cornea and to spread to the iris, ciliary processes, and cornea, ending in destruction of the eye by panophthalmitis and subsequent shrinking. In the most favourable case it is likely to damage the cornea, and to leave a closed pupil with dragging of the iris towards the cicatrix. The inflammation is probably of septic origin, and a vigorous disinfecting treatment should at once be adopted. But this is not the only indication; an eye which easily succumbs to septic influence is probably an eye of feeble vitality, and every possible effort must be made to improve its nutrition. The lids being carefully separated, the surface of the eye is to be cleansed from pus by means of warm water or boracic acid lotion several times during the day; after each cleansing, finely-powdered iodoform should be dusted on to the conjunctiva and outside the lids; and then a hot fomentation should be applied. The conjunctiva, if much swollen, should be incised lightly with a cataract-knife, or scissors, to give escape to blood and serum, and at the same time a good nourishing diet, with a liberal allowance of alcohol in the form most acceptable to the patient, should be given. If there be much pain, ease must be given by morphia. Some Continental authorities have lately advised still more vigorous measures, namely, opening up the wound and injecting the anterior chamber with a saturated solution of boracic acid, or a 5 per cent. solution of salicylic acid, at intervals of eight or twelve hours (Horner), and again, by applying the platinum wire galvano-cautery heated to a white heat to the whole length of the wound (Abadie).

Iritis, apart from that which occurs with suppurative inflammation, is a common complication. It is usually caused by the irritation of cortical substance remaining in the eye, but is greatly furthered by systemic disturbance, such as may arise from constipation, lithiasis, chill to the surface, loss of sleep, and emotional upset; it may also arise from incautious exposure of the eye to light too soon after the operation. One or two leeches to the temple or lower eyelid, a purge, atropine six or eight times during the twenty-four hours, with careful protection of the eye and head from draught, are the chief remedies. The iritis is of the plastic variety, and often causes more or less occlusion of the pupil. If it be so severe as to involve the ciliary processes, and be accompanied by much loss of tension, the eye is in great danger, and there is the further danger of sympathetic ophthalmitis. Incarceration of the iris in the cicatrix is likely to cause iritis and prolonged irritability of the eye. Usually it leads to some irregularity in the surface of the cicatrix; the tissue which unites the lips of the wound bulges at one or more parts, and may become prominent along its whole length, a condition known as a cystoid cicatrix. The bulging part may be punctured with a needle a time or two, so as to evacuate the anterior chamber, and thus, by lowering the pressure on its inner surface, to give it a chance of contracting. If it persistently recur, the tension of the eye will probably be found to be in excess, and the cause of this may be looked for in a partial obliteration of the angle of the anterior chamber. The proper remedy is then either an iridectomy, or a sclerotomy. Moderate prominence of the cicatrix is not of itself dangerous to the eye, but it exposes it to risk of easy infection from without, and destruction by suppurative inflammation extending to the uveal tract. Inversion of the edge of the lower lid to such an extent as to irritate the eye sometimes occurs during recovery from cataract-extraction. It may usually be remedied by coating the outer surface of the lid quite up to its margin with collodion, so as to cause strong contraction of the skin; the application must be repeated from day to day.

After recovery from the operation the pupil is left, in the most successful cases, entirely free from opacity of any kind; in a considerable proportion of cases it is occupied by a more or less opaque membrane consisting of retained lens-matter, or inflammatory exudation adhering to the capsule and iris. Such obstructions are sometimes spoken of as secondary cataracts; it is better, however, to use the terms primary and secondary cataract only as they are used above, i.e. in the sense in which they are used also in relation to glaucoma, and for the conditions in question to use the terms secondary capsular membranes, capsular opacity, or closed pupil, or to designate them by the general term *after-cataract*, the equivalent of the German 'Nach Staar.' They are dealt with differently according to their density. The thinner films are readily divided with two discision needles. When the iris is adherent to the obstructing membrane, iridotomy gives the best results with the least risk. *See* Iris, Diseases of the. In all cases the cut should be across the fibres of the iris as far as may be, not in the direction of their length; their retraction on being severed then serves to widen the aperture. Instead of iridotomy the following method (Noyes) is sometimes available. A linear cataract-knife is passed through the cornea near to its outer margin and out again near to its inner margin by puncture and counter-puncture; before it is withdrawn from the chamber its point is made to perforate the opaque membrane. A blunt iris-hook is passed in through each of the corneal apertures and through the puncture in the membrane, and then, by drawing the two hooks apart, the latter is torn more widely open without dragging on the ciliary processes.

Traumatic Cataract.—In all cases of injury to the eye involving damage of the lens, the first object of treatment is not to deal with the cataract, but to save the eye from destructive inflammation. If there be a prolapse of the iris which cannot be reduced, it is usually best to excise the prolapsed portion as fully as possible, making an incision, if necessary, as for an ordinary iridectomy, in order to prevent its incarceration in the cicatrix. To prevent iritis, atropine should be used freely and frequently; iodoform in fine powder should be dusted upon the wound, to lessen the risk of septic inflammation; and iced compresses should be applied over the closed lids. If there be much injection, two or three leeches should be applied at once to the temple. Next to the danger of destructive inflammation is that of the onset of glaucomatous tension. The older the patient and the more rapid the swelling of the lens, the greater is this danger. In the absence of any serious complication of either kind, no operation for the removal of the cataract should be undertaken until the irritability of the eye has quite subsided; but if inflammatory symptoms set in, or if the eye becomes hard, the lens must be removed as soon as possible. The operative treatment of a traumatic cataract is the same as for an ordinary cataract at the same time of life. In many of the more severe injuries involving the lens, the most urgent question is whether the eye should not be at once removed in order to preserve its fellow from the danger of sympathetic ophthalmitis. For the indications to be followed in such cases *see* Sympathetic Ophthalmitis.

Priestley Smith.

CATARACT-GLASSES.—Aphakia, or absence of the crystalline lens, involves, in almost all eyes, a high degree of hypermetropia, and in all eyes an absolute want of accommodation. The final step in the treatment of a case of cataract is, therefore, to prescribe glasses which neutralise these deficiencies. An emmetropic eye will, after removal of its lens, in most cases require for distant vision a spectacle-lens equal to about 11 dioptres (3½ ins. focus), and for reading one of about 16 dioptres (2½ ins. focus). Theoretically it might appear that, in the absence of accommodative power, a different lens would be required for every different distance, but practically two are enough, for the effective power of each can be varied considerably by placing it further from or nearer to the eye; the further from the eye the greater the power obtained, and *vice versâ*. Thus, with his distance glass, the patient can accurately focus objects 3 or 4 feet away by placing the spectacles a little further down his nose, and with the reading glass, which is usually focussed for 10 or 12 inches, he can get clear vision at a shorter distance by the same means. Eyes previously hypermetropic will usually require stronger glasses than the foregoing; myopic eyes will require weaker ones; but the strength of the glass required to produce emmetropia after removal of the lens bears no very exact relation to the pre-existing condition of refraction, for the lowering of the refraction produced by loss of the lens is not the same in all cases; a pre-existing myopia may depend on elongation of the eyeball, or upon changes in the lens itself arising with the onset of the cataract. In cases of very high myopia (far point at about 3 ins.) the removal of the lens may bring the eye into the emmetropic condition. In many cases the operation produces another refractive change, viz. corneal astigmatism. This may arise either through imperfect coaptation of the lips of the wound or swelling of the corneal or scleral tissue, or through traction upon them from within by pupillary membranes. The maximum acuity of vision is not attained until the astigmatism is corrected by an appropriate glass, but such correction should not be made too soon, as the degree of the astigmatism is apt to alter during the first few months. In some cases it is sufficiently corrected by merely sloping the ordinary spherical glass.

The acuity of vision after a cataract operation as tested in the usual way may reach $\frac{20}{20}$, or may fall short of that standard by any amount; $\frac{20}{70}$ may be considered a good result, but a lower degree than this will be appreciated as a boon when previously the patient has been unable to make his way about without help. Even when $\frac{20}{20}$ is obtained the operation is not to be credited with having restored a retinal picture equal to that in the normal-sighted eye, for the aphakial eye armed with a cataract glass obtains a larger retinal picture of a given object at a given distance than the normal eye. PRIESTLEY SMITH.

CATARRH OF THE BLADDER. *See* BLADDER, Diseases of the.

CATARRH OF THE EAR. *See* EAR, MIDDLE, Diseases of the.

CATGUT LIGATURE. *See* LIGATURES.

CATHETERS are hollow instruments for emptying the urinary bladder. They are tubes constructed of silver or of flexible material. The silver instruments are about eleven inches long, of equal thickness throughout; closed and rounded at one end (the beak) to slide along the urethra, and furnished with two rings near the open end (the mouth) to which tapes may be attached when the catheter has to be retained by the patient. About a quarter of an inch behind the beak two slits are cut—the eyes—to allow the urine to enter the catheter when the beak has passed into the bladder. For eight inches from the mouth the instrument is straight; but the last three inches are bent round a fourth of a circle which has a diameter of four inches; so that the beak is placed at a right angle with the direction of the stem. As the rings near the mouth are fixed on each side of the stem, they indicate the direction of the beak, which is in a plane parallel to that of their openings. Each instrument has a wire stylet. The catheters range in size from No. ¼ English to No. 12; the first has a diameter of 0·06 inch; the latter, 0·25 inch. Larger ones than these are seldom employed. This, the English scale, does not advance in equal steps, and also varies with different makers. The French scale ranges from No. 1 to No. 40, and each numeral denotes the circumference of the catheter in millimètres.

The flexible catheters of woven silk have two principal forms. The English, so-called 'gum elastic,' are of the same thickness throughout, have an eye near the beak, and are mounted on a wire stylet. Highly flexible when warm, they stiffen when cold, and thus can be given any required curve, which they will retain until again heated. The French flexible catheters taper for the last three inches to the beak, becoming very pliant and fine near the point. The beak itself is rendered blunt by ending in a small swelling or 'olive'; hence the name 'olivary' applied to these catheters. They retain their pliancy in all cases, and cannot be made to adopt a curve. A well-shaped one should be very smooth, have eyes with nicely-rounded edges; and when the point or beak meets an obstruction, the flexible neck behind it should yield at once in a sharp bend, not in a gradual curve.

Besides these two forms there is the so-called 'sonde coudé' or elbowed catheter. Made of the same flexible material, this is bent half-an-inch behind the beak to an angle of 45° with the stem, and this bend is sometimes again bent half-an-inch further back, when the catheter is termed 'bi-coudé,' or doubly-elbowed.

Catheters are also made of vulcanised india-rubber or of celluloid. The former are valuable from their extreme suppleness; the latter from their smoothness and insusceptibility to roughening by phosphatic incrustation. *See* BOUGIES.

BERKELEY HILL.

CATHETERISM.—The art of passing catheters. This is practised in various ways, according to the different conditions of the urethra and neck of the bladder which render the artificial evacuation of the bladder needful. These conditions are described in the articles on BLADDER; PROSTATIC HYPERTROPHY; RETENTION OF URINE; STRICTURE OF THE URETHRA, &c.

CATLIN.—An old form of amputating knife, having a narrow straight blade with a double cutting edge. It was used chiefly in amputations of the leg and forearm.

CAUSTICS, agents used for the destruction of tissue, may be classified in two divisions, viz. chemical and thermal. The latter includes the galvanic and actual cautery, which are treated of in the article CAUTERY. The chemical or 'potential' caustics may be arranged in three main classes, viz. alkaline, acid, and mineral.

I. The ALKALINE CAUSTICS include (1) Potassa fusa, hydrate of potash, caustic potash.

(2) Hydrate of soda, caustic soda.

(3) Lime, dehydrated, unslaked or quick.

Various combinations of these have been devised, such as 'Vienna paste,' which is made with quicklime, 2 parts; caustic potash, 1 part; mix just before use with sufficient alcohol to form a soft paste. 'Caustique Filhos,' lime, 1 part; caustic potash, 2 parts; prepared in moulds. 'London paste,' lime and caustic soda, equal parts.

(4) Ethylates of sodium and potassium.

All these act mainly by virtue of their great affinity for water, withdrawing it from the tissues with which they are brought in contact; they also readily decompose and dissolve the nitrogenous components. Potash and soda have a high diffusive power, and are not neutralised by the natural fluids of the tissues, which are themselves nearly all alkaline, therefore their action tends to spread. In their effects they are *deep*, as distinguished from *superficial* caustics; the slough produced is dark, moist, and leathery; the potash compound is more powerful than the soda.

The action of quicklime is less diffused and more superficial, and on the skin proper not very severe; but when applied to mucous membranes it causes much pain and an extensive slough. The addition of lime to the caustic alkalies, as in the pastes described, serves to render them less deliquescent, and so to keep their effect more under control.

The ethylates act in a similar but more limited manner, and with less pain, especially if opium be combined with them; a solution in spirit is commonly used, and on first contact causes only redness; but when the textures part with water, caustic soda (or potash) is immediately formed, and destruction of tissue commences.

II. The ACID CAUSTICS include the mineral acids—nitric, hydrochloric, sulphuric, chromic, and manganic; and the organic acids—carbolic, glacial acetic, pyrogallic, and salicylic; with which may be grouped iodine and bromine. The mineral acids act only superficially if lightly applied, destroying the epidermis; but if kept in contact, they penetrate and destroy the tissues deeply, abstracting water from them, coagulating albumen, and combining with alkaline bases; the latter effect limits their caustic action.

Hydrochloric acid penetrates less deeply than nitric or sulphuric acid, and the slough produced by it is at first white; that of sulphuric acid is brown and firm. Nitric acid turns the part yellow, picric acid being formed in the tissues. Chromic and manganic acids and their compounds act almost wholly by oxidation; from the former, when applied over an extensive ulcerated surface, absorption, with serious symptoms of vomiting, diarrhœa, and collapse, has occurred. The same may be said of strong solutions of pyrogallic acid.

Chromic acid is slow in action, but not extremely painful, though it penetrates deeply; it requires care in protecting neighbouring parts. Made into a paste with a little water, it turns the skin yellow, brown, and, later, black, and causes a slough which is detached in one or two days.

Glacial acetic acid is much more superficial in action, often producing only vesication; it is, however, a useful application to warts and callosities, destroying them in successive thin layers. A special formula containing it, used for syphilitic warts, bears the name of Plenck, and is as follows:—℞. Alcohol, acid acetici āā f℥ss., hydrarg. perchloridi, aluminis, camphoræ, plumbi carbonatis, āā ʒss., to be applied carefully twice daily.

Carbolic acid, the action of which is also superficial, is not often used as an escharotic, but is employed pure or mixed with sufficient liquid for solution as a moderately caustic astringent to the cervix uteri, and, combined with one to three parts of spirit, is much esteemed by Hardy in superficial lupus; it penetrates the tissues, but not so deeply as potash; it is less painful and leaves a smoother scar. The pure acid injected into the slough of a furuncle or carbuncle allays pain, limits the inflammation, and hastens the separation of the slough.

Salicylic acid is much milder in effect. It is doubtful whether it forms a compound with albumen or not; but when applied in strong solution to previously cut warts and corns, the base of these separates in layers. It is more useful in post-mortem warts, though it causes some smarting pain for a short time after its application; it must be re-applied daily until the growth disappears. It is very irritant to mucous surfaces, but is well tolerated in some cases; ulceration of the throat has been caused by its internal administration.

Iodine in strong solution is occasionally used for its caustic properties, especially in snake-bite; and a solution in oil of tar—one or two drachms to the ounce (Coster's paste)—is an efficient, though painful, application for ringworm; it often vesicates.

Bromine is much more powerful, quickly oxidising and destroying organic tissues, coagulating and combining with albumen, and forming a brownish slough. Bromide of potassium, sprinkled in fine powder over an ulcerated surface, acts as a mild caustic with advantage (chlorate of potash is also used in the same manner).

III. The MINERAL CAUSTICS include the following:—

1. *Arsenious acid or oxide* (*white arsenic*), which is used either mixed with 3 or 4 parts of mucilage, or combined with mercury, as in the following pastes or powders, named after their inventors; but their ingredients may be varied somewhat according to the case. Cosme's: Cinnabar, 2 parts; arsenious acid, 1 part; powdered pterocarpus draco (dragon's blood), 2 parts; made into a paste with mucilage. This is similar in composition to the arsenical powder of Dubois, but contains proportionally more arsenic. Dupuytren's powder is made with arsenic 4 to 10 parts; and calomel 90 to 100 parts (by weight). Miss Plunkett's contains Ranunculus acris and flammula, of each 1 ounce; arsenious acid, 1 drachm; sulphur, 100 grains; worked into a paste and dried in the sun. There are many other empirical formulæ, of which Manec's is still used in France, and is made as follows:—Arsenic, 1 part; cinnabar, 5 parts; burnt sponge, $2\frac{1}{3}$ parts; made into a thick paste with water. That of Frère Come contains the same ingredients, but has 1 part of arsenic to 4 of cinnabar and 10 of charcoal.

2. *Acid nitrate of mercury* is perhaps the best and most manageable liquid caustic.

3. *Mercuric chloride* (corrosive sublimate).

4. *Chloride of antimony* (butter of antimony) is not now much used; but has the advantage of penetrating well and of not producing much pain or inflammation, and after the separation of the eschar, a clean, healthy surface is left. A preparation of it, formerly celebrated, but now little, if at all, used in this country, is the paste of Landolfi, which was made with 1 drachm of chloride of bromine, 2 drachms of chloride of antimony, and 3 drachms of chloride of zinc, mixed with sufficient liquorice powder to form a paste. According to another, and probably original, formula, an equal part of chloride of gold is substituted for the zinc. Hebra, however, discards the metals, and his 'modified paste of Landolfi' contains only concentrated hydrochloric acid with sufficient liquorice powder to form a paste.

5. *Chloride of zinc.*—Canquoin's Paste, as used by Liston:—Chloride of zinc, 1 part; wheaten flour or plaster of Paris, 2 to 3 or 4 parts, according to the strength desired, and water sufficient to make a paste. This caustic destroys the part in a

direct ratio with the thickness of the layer applied.

Fell's Paste:—Chloride of zinc, 1 part; extract of sanguinaria, 1 part; extract of stramonium, 2 parts; to be thoroughly mixed.

In preparing the paste used at the Middlesex Hospital, 'Liquor zinci chloridi cum opio' is first made as follows:—Zinci chloridi ʒxvj.; pulveris opii ʒjss.; acidi hydrochlorici fʒvj.; aquam bullientem ad Oj. Macerate the opium in twelve ounces of boiling water for twelve hours; add the acid and filter, then dissolve the chloride of zinc in the filtered liquid, and make up to twenty ounces with distilled water. Two drachms of flour are added for every ounce of liquor, mixed smoothly in a mortar, and heated over a water-bath until of proper consistence.

6. *Sulphate, nitrate, and acetate of zinc.*

7. *Perchloride of iron.*

8. *Nitrate of silver* (lunar caustic).

9. *Sulphate, nitrate, and acetate of copper.*—The so-called 'lapis divinus' is made with equal parts of sulphate of copper, alum, and nitre, fused together with 4 parts of camphor.

The mineral caustics differ somewhat in their mode of action, but resemble each other, to a great extent, in coagulating albumen, and thus arresting vital processes. Arsenic especially illustrates such arrest, its result when applied in suitable form being a 'mummifying of tissue.' With this drug, as with mercury, antimony, and chromic acid, the possibility of systemic absorption has to be carefully considered, serious and even fatal results from general poisoning having followed the application of a 4 p.c. solution to a small ulcer. Hence these agents are not used so much now as formerly.

The chloride of zinc is probably the best solid caustic, and the one now in most frequent use, but it is deliquescent, and apt to penetrate too deeply if used pure; it should therefore be employed in the form of one of the above-mentioned pastes. The nitrate of zinc is commended by Mr. Marshall as penetrating deeper and with less pain; advantages which were claimed also by Sir J. Simpson for the sulphate, the slough produced by which he found to separate earlier than that formed by the chloride.

The stronger solution of perchloride of iron, though commonly used only as a styptic and astringent, acts as a caustic to mucous membranes, and will cause a slough.

Nitrate of silver, which popularly represents the type of *caustic*, acts only as such when thoroughly applied in a concentrated form—e.g. when a solid pointed stick is firmly pressed into a soft tissue until the latter is broken up. A similar remark may be made as to the use of sulphate of copper and its preparations.

USES AND MODE OF APPLICATION OF CAUSTICS.—1. *To make an issue.*—Take a strip of soap plaster with a hole half an inch square in its centre, and apply it over the part to be treated. In the hole place a small piece of caustic potash about the size of a pea, and cover it over with a second strip of plaster, and in two to three hours a slough will have been formed.

2. *To open an abscess.*—The method of proceeding is the same as for an issue, although it is now rarely, if ever, resorted to. Previously to the introduction of the aspirator and antiseptic modes of treatment, this was a favourite method of effecting the discharge of an hepatic abscess, the slow action of the caustic leading to adhesions which prevented the escape of pus into the peritoneal cavity.

3. *Counter-irritation.*—Besides issues, the cautery is a powerful and useful counter-irritant in some chronic inflammations.

4. As a *hæmostatic*, a pointed stick of silver nitrate is serviceable in arresting the bleeding of a leech-bite or the base of an excised wart. For more extensive surfaces the actual cautery, at a dull red heat, is necessary.

5. *For destruction of unhealthy ulcerated surfaces, morbid growths, &c.*

In strumous ulcers with overhanging, thickened edges and slowly extending surface, the application of a caustic alkali to the edges and base is often beneficial, and equal parts of caustic potash and water, as used by Dr. Liveing, is one of the best applications for strumous lupus. The surrounding healthy skin should be protected by plaster or oil, and the cauterised part sponged with dilute acetic acid after the application. Fungating granulations may be rubbed down with solid silver nitrate or copper sulphate; the former is also thrust into the nodules of *lupus* to break down the morbid tissue. Chloride of zinc paste, in any of the forms mentioned, is also much used for *lupus* and *rodent ulcer*, the application being made on a piece of thin linen, and allowed to remain for twelve to twenty-four hours at a time; after separation of the slough by poultices a fresh application may be made. In *hospital gangrene*, and similar cases of rapid sloughing, the part should be scraped with a blunt or wooden knife, and fuming nitric acid applied by means of a glass rod. The mineral acids mixed with charcoal are also suitable, but bromine seems to have special efficacy; after thorough cleansing of the wound a solution may be used containing one ounce of it with two drachms of bromide of potassium, and four ounces of water. The intensely irritant effect on the mucous membrane of the nose and air-passages is its chief drawback.

Hydrochloric acid is a useful application to *cancrum oris*, diphtheritic membrane, ulceration of the tongue, and phagedænic ulceration of the tonsils, and nitric acid to the non-infective chancre; the parts must be only lightly touched with the acid. Small ulcerated surfaces and spots of acne may be treated with the acid nitrate of mercury, which is conveniently applied with a wooden match; this is also very serviceable for outlying nodules of lupus. Morbid growths may be removed by a heated iron driven into and through them in various directions, or by Fell's paste, spread on thin linen, and applied repeatedly after the separation of each slough. When the surgeon wishes to use the paste after a cutting operation, he should staunch the bleeding by the firm application of a pad of lint for twenty-four hours, after which the caustic may be spread on the dry surface. This procedure ensures the efficient action of the paste.

In epithelioma of limited extent, as in other forms of malignant growth, the knife is usually preferred; but in cases where this is inadmissible, a paste of chloride of zinc is very serviceable. If the skin is unbroken it should be destroyed by nitric acid, and the paste introduced through incisions made in the eschar formed. Maisonneuve used a paste, dried in pointed pieces, which could be inserted into and round the tumour; and Paget applied small lancets of wood coated with the previously melted chloride. When the surface is already ulcerated, a zinc paste may be spread over it for a thickness of, say, half an inch, and kept in contact for six or twelve hours, when it will have destroyed tissue to the depth of about one inch. This slough will separate in a week, leaving either a fresh cancerous surface exposed for another application, or a healthy granulating sore. Simpson applied the sulphate of zinc, in powder or mixed with a small quantity of glycerine, one ounce of crystals to one drachm of the latter; he found that the slough usually separated in five or six days.

For quite superficial nævi, a careful application of fuming nitric acid on a glass rod is very successful. The surrounding skin should be protected with oil, and the superfluous acid neutralised with a solution of carbonate of soda. Other mineral acids may be used, or the part may be painted with an arsenical solution or the ethylate of sodium. The latter is very good for the smaller nævi: it causes little pain, and is efficient; no water must touch the surface during its application. The same caustics have been used to obliterate varices. The deep forms of nævi require the actual cautery. C. D. F. Phillips.

CAUTERY.—The cautery consists of a piece of metal, generally iron or platinum, raised to a variable temperature by the heat of a flame or fire, or by some special means, as in the galvanic or in Paquelin's cautery.

It is used for the following purposes: for dividing soft tissues, as in removing portions of the tongue and cervix uteri; for destroying vascular and fungating growths; for arresting hæmorrhage; and for purposes of counter-irritation. The degree of heat employed varies to some extent in each of these cases. Three degrees of heat are recognised—white, red, and black—and it is stated that when heated to the white degree the cautery gives little pain.

A bright red heat is employed for dividing tissues. In all cases this operation must be done slowly, and if hæmorrhage occur, the heat must be reduced and the bleeding points retouched. When the metal is covered with blood and charred tissue, it is difficult, as in Paquelin's cautery, to see the exact colour. The temperature can then be estimated by the rapidity of the cutting and the presence of blood.

For arresting hæmorrhage, a dull red or black heat is the most effective. When a little too cool, the tissues are apt to adhere to the metal, and bleeding to follow its forcible removal. If this occur with Paquelin's cautery, raising the temperature slightly will separate the metal; but with the actual cautery the tissues must be detached by a spatula or blunt director. The surface must during the whole time be kept as dry as possible, the sponge or lint being pressed on the surface, not drawn or rubbed over it, for fear of detaching the eschar.

For destroying growths, a red heat, slightly brighter than the dull red, is used. The tissue is gradually burnt down, the cautery being held in contact with the surface some time, and the part kept dry. In puncturing nævi, when the actual cautery is used, it must be made as hot as possible at first, to penetrate the skin.

For purposes of counter-irritation a white heat is recommended, and is said to produce little pain. The cautery is drawn lightly over the skin in vertical lines. It is employed in disease of the joints, especially of the knee, and also in spinal caries. This mode of application will produce an eschar, the depth of which will depend on the amount of pressure used. A slighter effect may be obtained by holding the heated metal a short distance from the surface, and passing it over more slowly, thus producing a rubefacient action, or even blistering. It is well, in applying the cautery for this purpose, to avoid points where ulceration is likely to be troublesome, as over subcutaneous bones and superficial tendons.

The benzoline or thermo-cautery of Paquelin is now employed for most purposes, and the only precaution necessary in using it is to take care that the point is thoroughly heated in the spirit-lamp before any benzoline vapour is forced into it.

The Galvanic Cautery.—The heat in this cautery is produced by the passage of an electric current through platinum wire, fixed in a suitable insulated handle. This metal, on account of its high fusing point, can be kept at a white heat for some time.

The difficulty of obtaining a constant battery with sufficient power is the practical inconvenience connected with the galvanic cautery. It is also expensive, and requires frequent attention. Except where a cautery-écraseur is required, it is now almost entirely replaced by Paquelin's thermo-cautery.

The battery.—In every battery there should be a small number of cells (four to six), with large acting surfaces. The bichromate of potash battery is the one now most commonly used. The elements are carbon and zinc, the fluid an acidulated solution of the bichromate. When not in use the elements should be raised out of the fluid. This is accomplished in a battery made by Messrs. Meyer and Meltzer by closing the lid. One charge will last for several operations, but so quickly do the elements polarise that the current is uncertain, and liable at any moment to stop. Should such an event happen the working may be renewed by blowing air in with a bellows. This battery has the further advantage that it can be kept in a closed box, there being no acid fumes to destroy the connections.

The Bunsen arrangement supplies a reliable current, and where it can be attended to by an electrician, is no doubt the best. The elements are best arranged in vertical cylindrical jars. The block of carbon—preferably, on account of its porosity, retort carbon—is suspended in nitric acid contained in a porcelain jar. This is placed in a wide vulcanite jar containing water acidulated with sulphuric acid (1–8), and between the two is the zinc plate folded into a cylinder, a gap of about an inch intervening between the edges. The connections are of copper. The objection to this battery is the necessity for decanting the fluids when not in use, since the nitric fumes destroy the connections. If, however, this be done, and the elements carefully washed and the connections dried, the battery will not prove expensive and may be relied upon. Before long probably the necessary heat will be obtained at a moderate cost, from the 'accumulator.' Already Mr. Buchanan has used this electric reservoir, and the writer has maintained a platinum wire at a white heat, for some time, with two of Faure's accumulators. The great weight and the cost prevent the general adoption of this plan at present.

The connections and handle.—The current is conducted through thick copper wires, so as to diminish as much as possible the resistance, to a special handle. This is composed of two brass rods which are insulated by talc fitted in a wooden handle; at the lower end are clamps for connecting the wire, and to the other is soldered, by common solder, the platinum wire. A movable button in the handle works a metal cylinder by which the continuity of the current may be made or broken. This interrupter has been arranged so as also to be worked by the foot.

The shape of the terminal will depend upon the use to which it is to be put. That just described furnishes a point or small loop for puncturing, or cauterising, small surfaces; for larger surfaces the wire is coiled round a porcelain cone. The chief use now of this cautery is for removing growths by surrounding them with a wire. The platinum is made into a loop, the ends carried through two brass tubes and wound round ivory rods by turning a button, so that the tumour can be gradually constricted and burnt through. The current is conveyed through the brass tubes to the wire.

Application.—It is only necessary to describe the écraseur action, and here an advantage possessed by no other cautery is manifest—viz. that the wire can be placed *in situ* before the heat is applied. The loop is carried over the growth, tightened, and the heat applied gradually; if too much heat be used the wire will cut through like a knife, and no time be given for hæmostatic action; therefore the wire must be tightened very slowly. When acting well there should only be heard a low frizzling sound with little smoke.

When the part to be removed cannot be surrounded—as, for example, the tongue—the wire must be carried through at the desired point or points, and the part removed by one or more cuts. The wire is made to traverse the part by a large needle with a sunk loop at one end, or it may be passed through a canula. It is specially used for removing intra-laryngeal, nasal, and uterine growths, and, as said above, for extirpating the whole or part of the tongue affected with malignant disease.

PAQUELIN'S CAUTERY, invented and introduced by M. Paquelin in 1876, has now almost replaced both the actual and galvanic cauteries.

The essential principle is that platinum, when raised to a certain heat, becomes incandescent when brought into contact with a mixture of air and benzoline vapour. A stream of air is passed, by means of the ordinary spray-bellows, into a bottle containing benzoline, and the resulting mixture of air and benzoline vapour conducted through an indiarubber tube to the cautery. This is hollow, and consists of a wooden handle through which passes a metal tube. To the end of this is attached the indiarubber tube, and into the other is screwed, by a piece of the same metal, a hollow platinum cone. The tip of the platinum is heated in the flame of the spirit lamp until it begins to glow; this ignites the highly inflammable benzoline vapour forced into it by a few sharp compressions of the handball, and the metal is raised in a few seconds to a red heat. The temperature can be maintained for any length of time by gently compressing the ball, and moreover can be regulated to a nicety. The cautery is sold in a compact box containing usually three platinum heads: one wedge-shaped, to act as a knife; a second furnished with a broad button for large surfaces; and a third with a point suitable for puncturing nævi and piles. Various other terminals have been made to suit particular localities; for example, the knife-end is curved and this renders it more useful in cavities, as in dividing the cervix uteri. A scissors-terminal is also made.

It is necessary to use rectified spirit in the lamp, for the double purpose of increasing the heat and preserving the platinum. The benzoline must be of the specific gravity of 0·709, and the bottle never more than half-full. After remaining some time in the bottle the benzoline will not ignite, so that it is well to use a small quantity at a time, keeping the reserve in a special flask. CHARTERS J. SYMONDS.

CELLULITIS, or Diffuse Cellular Inflammation, may clinically be looked upon as a form of erysipelas, and by many authors is classed as a variety of that disease. It is characterised by the same spreading inflammation and by the same atonic character. It affects, however, only the cellular tissue; occurring in those situations where there is no skin, as in the pelvic cellular tissue, or in the subcutaneous cellular tissue, the skin not being involved, or only secondarily affected, by the inflammation.

It presents itself in its most virulent form after the introduction of a septic poison, as in dissection wounds, or after the bite of one of the less poisonous snakes. It may occur also in the pelvic cellular tissue after wounds or surgical operations, in women, after parturition; and after scalp wounds or injuries of other parts involving the cellular tissue.

When it occurs as the result of a poisoned wound, it possesses the peculiarity that it may attack tissues remote from the wound, and between which and the puncture no direct communication can be traced. Moreover, the puncture may be quite healed or apparently healthy. Thus, in a dissection wound of one of the fingers, the cellular tissue in the pectoral region may be the seat of the disease. When it occurs as the result of a simple wound, it runs the same course as an attack of ordinary erysipelas, starting from the seat of injury, but implicating the cellular planes.

The disease appears as a diffused swelling of the part affected. The swelling, at first œdematous, speedily becomes brawny; or it may be œdematous in some parts, brawny in others. The skin is slightly reddened and presents a mottled appearance, but there is no well-defined limit to the redness. There is great pain, of a tensive, burning character, which is increased by pressure. There is often inflammation of the absorbent vessels and glands. After a time the swelling becomes soft and doughy, and there is an indistinct sensation of fluctuation. Occasionally crepitation may be perceived, from putrefactive changes. The skin later on becomes more involved and of a darker colour, and may, eventually, pass into gangrene, unless relieved by timely interference. The constitutional symptoms are of an exceedingly grave character. There is great excitement and prostration of the nervous system, especially where the disease is the result of the introduction of a septic poison, and speedy collapse. The fever is of a marked asthenic type, with a high temperature, generally profuse sweating, a quick and feeble pulse, a brown and dry tongue, vomiting and diarrhœa, and low muttering delirium.

In extreme cases death results in two or three days, but in those in which the general symptoms are not so severe, it may be delayed for several weeks, or recovery may take place.

The *diagnosis* of the subcutaneous form of this disease is generally simple, but when the mischief is deep-seated it is by no means easy. The presence of an œdematous swelling, accompanied by severe constitutional symptoms and rapid prostration, should always put the surgeon on his guard, and if any reason exists for suspecting the presence of deep-seated cellulitis, an exploratory puncture should not be omitted.

Treatment.—In the treatment of cellulitis decisive measures are necessary, and the only effectual way of preserving the skin and preventing sloughing is by means of incisions. Hence they should be made early, before the parts have lost their vitality. The object of the incisions is to relieve tension and give exit to the effused inflammatory products; and, to attain this end, it is better to make a number of small incisions (say some two or three inches in length) rather than one long cut through the inflamed structures. The incisions should embrace the whole extent of the tense parts. It is desirable that they should be made parallel to each other, and that the extremity of one incision should overlap that of the second, as by this means the greatest relief is given to tension. They must be carried deeply into the infiltrated and gelatinous-looking cellular tissue, and if the disease has extended beneath the fascia, it must be freely incised. After the incisions have been made, warmth and moisture, in the shape of fomentations and poultices, must be applied in order to facilitate the escape of the effused fluids.

As regards general treatment, the free and early administration of tonics and stimulants is necessary. Wine and brandy, combined with bark and ammonia, or other tonics, form the only reliable treatment, and they must be given with no niggard hand.

The issue of a case of diffuse cellulitis will often depend upon whether the patient is able to take and digest large quantities of stimulants. So long as he can do this there is always good ground for hope, and the amount of brandy and wine which patients suffering from this disease can assimilate is sometimes astonishing. If, however, the stimulants upset the digestive organs and sickness comes on, or the patient begins to refuse them, speedy prostration supervenes and rapidly terminates the life of the patient. Opium, or other narcotics, are often required in this affection, in order to allay nervous irritability and diminish pain. T. Pickering Pick.

CERUMEN. *See* Ear, External.

CERVIX UTERI, Amputation of the. This operation is generally performed either for the removal of malignant disease, or for the cure of the troublesome results which may follow hypertrophic elongation of the cervix. Operations for malignant disease must be conducted, in the case of the uterus, upon the same principles as in any other form of cancer or sarcoma; but in this special case the difficulty of removing the entire morbid growth is often peculiarly great, and the surgeon can seldom feel sure that he has done so. As anything like a free use of the knife or cautery in the neighbourhood of the uterus entails great risks, it follows that, if the cervix be amputated and there be the least suspicion that some of the disease is left behind, the use of scraping instruments or strong caustics will be rendered necessary, any further cutting operation being out of the question, unless total removal of the uterus be meditated. All these questions are dealt with in standard works on diseases of the uterus, to which the reader is referred.

Turning to the consideration of the operation alone, it must be borne in mind that the surgeon aims at removing just as much of the cervix as he desires—not too little, so as to nullify all premeditated benefits, and not too much, so as to involve several serious risks. He also presumes that the canal of the uterus will not be obstructed after the operation. It happens that even a very small experience shows how very hard it is to remove precisely as much of the cervix as is required. The position of the cervix prevents that free use of the hand and perfect control of the part to be cut through, which can be brought into play when a limb is amputated. Even the most skilful operators have met with very bad results when employing the knife or any kind of écraseur. The wire or chain not unfrequently drags down the posterior *cul-de-sac* of the vagina, and tears away a piece of peritoneum from Douglas's pouch. To avoid this disaster, which may be followed by severe hæmorrhage or peritonitis, some surgeons have been accustomed to free the uterine part of the cervix by cutting away the vaginal mucous membrane round its reflexion on to the cervix; but this proceeding is not to be recommended.

The least objectionable, most successful, and most generally recommended instrument for amputation of the cervix is undoubtedly the galvano-caustic wire. The patient being placed in the lithotomy position, and the vagina depressed by a Sims's speculum, the cervix is seized with a pair of vulsellum forceps, and drawn as low down as is needed, an assistant facilitating the process by pressing on the fundus uteri from above the pubes. The loop of platinum wire is then passed round the cervix as high up as is desired, and drawn tight. The next stage of the operation consists in the process of cutting through the cervix with the red-hot wire. If this be done in a hurry, the risk of hæmorrhage and of a slipping downwards of the wire, with consequent amputation of an insufficient portion of the cervix, will be very great. The advice given by Dr. Barnes should be followed. The wire being drawn so tight as to imbed itself in the groove which it forms in the tissues, it can then be made red-hot without any fear of its damaging the vagina. The loop must be made tighter as it burns through; time must be left after each tightening to allow it to get red-hot again, as the tissues must be burnt through, and on no account cut through by overtightening the knot. When the cervix is entirely burnt through, the stump must be cleaned by free syringing with ice-cold water; bleeding points may then be secured; and lastly, the vagina is plugged with lint soaked in some antiseptic solution. The cut surface will granulate and heal within a month. It is very necessary to pass a sound occasionally to avoid contraction of the uterine canal.

Alban Doran.

CERVIX UTERI, Stenosis of the. Authorities upon gynæcological questions are much divided in opinion as to the relation of dysmenorrhœa to organic stricture of the cervix uteri. Although stenosis of the cervix is intimately associated, in the minds of many, with painful menstruation, the relations of the two still lie within the domain of theory; and stenosis will, therefore, be here considered in its definite forms, ranging from a distinct contraction to absolute atresia. In all these forms there may be no symptoms of dysmenorrhœa throughout the course of the case.

Stenosis of the cervix may be congenital or acquired. The congenital variety is often associated with the small, tough, strongly anteflexed and ill-developed uterus seen in sterile women who have never menstruated, or whose catamenial show is scanty and attended with pain. As in such cases, little, if any, fluid escapes through the cervical canal; as the flow of that fluid is never sudden or rapid; and, lastly, as the fact of distension of the uterine cavity with retained fluid has not been proved in cases of stenosis, it is, at least, probable that the pain is due to causes other than obstruction. Acquired stenosis has been repeatedly observed as a result of partial amputation of the cervix, of injury during parturition, and, though to a limited extent, of inflammatory diseases and neoplasms in the canal. Putting aside the contraction of the canal, very common after the menopause, there can be no doubt that stenosis has been produced by the abuse of caustics or of scraping with the curette, and this fact has been frankly admitted by some of the advocates of these practices.

When, from any of the above causes, the cervical canal is found to be extremely narrow, resisting the withdrawal of the sound, stenosis of the cervix may be diagnosed. Difficulty in the introduction of that instrument, however great, is not satisfactory evidence; for, in cases of spasmodic dysmenorrhœa, the sound slips out with ease, though its entrance, aided by a considerable amount of force, may have taken several minutes. In such a case, there is generally severe pain as the sound passes through the os internum. In true stenosis, this pain is often absent. In a case of stenosis, menorrhagia may exist; in complete atresia this symptom is impossible. The diagnosis of a uterus distended by retained fluid may, it must be remembered, be very difficult. Circumstances may render it unadvisable to use the sound, and the swelling may be taken for pregnancy or a uterine tumour.

Should the surgeon be able to detect true stenosis, not amounting to atresia and accompanied by severe dysmenorrhœa, then, especially in an acquired case, he may dilate the cervix by bougies or tents, preferably the former. When atresia exists, the case will require very grave consideration. The distended uterus may be associated with dilatation of the tubes and its concomitant evils; and, again, operation may be followed by the disastrous results which have been known to occur after the puncture of an imperforate hymen. In such a case, it is advisable to draw down the cervix with a tenaculum forceps, after a Sims' or Neugebauer's speculum has been introduced into the vagina, and to puncture the obstruction very carefully with a very fine aspirating-needle. After aspiration, the best treatment is to keep the parts as aseptic as possible without active syringing. An iodoform pessary, of Ehrendorfer's composition, may be introduced into the vagina; it is an excellent means to this end, and sometimes takes three or four days to melt. The use of bougies will be required for after-treatment. Alban Doran.

CHANCRE.—A chancre may be defined to be any primary sore connected with venereal disease. The association may be direct or indirect, and it is not necessary that the sore should be on the genitals. Neither is it necessary that a chancre should lead to syphilis. There are chancres which infect the system, and others which do not. All chancres are contagious, and are produced by contagion only. All chancres are liable to affect the lymphatic glands nearest to them, and thus to produce bubo. The characters of the bubo will usually resemble those of the chancre. If the latter is hard, well-defined, and not inflamed, the enlarged glands will be hard, loose, and almost free from inflammation, but if the chancre be inflamed and suppurating, the bubo will very probably suppurate also.

It is exceedingly difficult to determine correctly the relationship between infecting and non-infecting chancres. The difficulties are much increased by the circumstances that the characters of the two are often seen together in the same sore, and that the one is very often introductory to the other. We shall probably be near the truth if we believe, that non-infecting chancres are produced by the contagion of inflammatory secretions from venereal sores of all kinds, which do not contain at the moment the specific virus of syphilis; or in some cases it may be the fact that the recipient is not liable to the specific contagion, having been temporarily protected by a previous attack. In yet other cases, it may be that the acute inflammation induced by the pus-contagion makes the site of the chancre unfavourable for the development of the specific virus. The school of dualists believe that there are, and have always been, two wholly different kinds of virus, which have no relation to each other, but produce their effects side by side. There is no great difference of opinion as to the facts; it is simply as to their interpretation and the terms in which they are described. For the unicist, the non-infecting sores are usually an appanage of syphilis; for the dualist they are wholly distinct. Both will admit that the contagion of non-venereal pus—from boils, for instance—may produce, when inoculated on the genitals, ulcers, which may have a certain duration, and may simulate the non-infecting sore; but both will also probably assert that the venereal non-infecting sore usually presents peculiarities. The diagnosis between the chancre which will infect the system, and the one which proves to be a local ulcer only, is often exceedingly difficult. In many cases, if a month or five weeks have elapsed since the contagion, it is often—indeed, usually—quite easy to decide, but in a few it may be impossible.

The feature which is of chief importance in the decision is the very peculiar kind of hardness which the sore often assumes. In well-marked cases this induration may be such as might be produced by a disc of cartilage. It causes the affected portion of mucous tissue, if it be in the roll of the everted prepuce (its most common site), to stand up in a sort of collar, and it is not necessary to use the finger to recognise the induration. When in other parts, as the skin of the penis, or elsewhere, it produces, not a collar, but a round patch or button, which is usually well circumscribed and but little inflamed. The sclerosis of tissues and the absence of common inflammatory action are the chief features. Sometimes the sore will not show any ulceration from first to last, and it is very common for the ulceration to heal and leave the induration still present. The size and thickness of the hardened patch may vary very much. The disc may be no bigger than half a pea or as large as a half-crown. Whilst the absence of inflammation and the presence of induration are the common features, it is yet quite possible that the sore may deviate very widely from rule in either direction. It may be acutely inflamed, and it may be wholly without hardness. These deviations probably depend chiefly on the peculiarities of the recipient, but they may also in some cases be due to the nature of the secretion in which the virus was conveyed. If the pus-secretion be of an irritating character, the inflammation caused may obscure the features of the specific induration. Thus chancres produced experimentally, and with secretions as little mixed as can be helped, run, usually, a more typical course than those which occur *au naturel.* In some cases the inflammation of a chancre becomes erosive, and assumes the features known as phagedæna. This process may entirely destroy the chancre and extend widely in the parts around. It seldom, however, occurs early enough to prevent the infection of the system.

Next in importance to the two conditions named, we have, as distinctive of the infecting or true chancre, its observance of stages. It has been well determined by experiments that, between the date of contagion and the full development of induration, a period of nearly five weeks will intervene. Observations on patients, when the infection has been accidental, are in accord with this. The first result of contagion is usually a little red point, which lasts only a few days and then wholly vanishes. During the fifth week the site of this point usually becomes irritable and again red, and very quickly develops slight hardness. Upon this hardness ulceration takes place, but, the induration continuing to widen, is still of much greater size than the ulcer. The ulcer usually secretes very sparingly, as has been already said. At the end of the sixth week the induration may be expected to be at its height, but in many cases it is very short-lived indeed, and may disappear in a few days, and the sore heal and be forgotten.

There is no fact more certain in medicine than that mercury can cause the sclerosis of a true chancre to disappear, and that it invariably does so in the most remarkable manner. We seldom see a chancre run its course without interference from this specific. If, however, the very largest indurations be left to themselves, there is reason to believe that they will not, as a rule, last long. The normal duration is, however, varied. They may, as first said, vanish before full development, or they may persist for many months. If mercury be prematurely interrupted, the chancre will indurate again, and in rare cases we encounter what are called 'relapsing chancres' in which the hardness returns over and over again in the exact site of the chancre, during several years. The periods specified are usually observed with great exactness in all cases of experimental chancres, and in all those which occur in vaccination. It is probable that the observations which assert that definite induration may develop in much shorter periods, or that its first occurrence may be delayed to much longer ones, are founded on error.

When the chancre has been produced by sexual contagion, the secretion causing the infection will almost always be mixed—that is, it will contain pus-elements, the products of inflammation, as well as the specific virus. From this it results that very often a pus sore is produced at once, or within a few days after the exposure. This sore may persist during the whole month which intervenes before induration sets in. In such cases a sore, which has had the characters of a non-infecting one during the first month or five weeks, finally develops those of the syphilitic kind and is followed by the usual results. Such a chancre may continue to suppurate after induration of its base has occurred, and may thus present 'mixed' features.

Another character which usually denotes an infecting sore is that it is single; or rather, perhaps, it should be said that the non-infecting are often multiple. The infecting sore is not always single, for there may be two, three, or more. If multiple, we may be sure that they all result from contagion at one and the same time, for it is impossible for a true chancre to produce others in the same person.

The characters assumed by chancres which do not prove infecting are very various. The sore is, however, invariably developed within a few days—it may be a few hours—of the exposure to contagion. As a rule only one sore is present at first, but there may be two or three. As a result of contagion from the pus secreted by the first sore, others may be produced, usually in its close proximity. If the part on which the sore has appeared is in apposition with another surface, this latter is almost always infected. The degree of inflammation, ulceration, &c., may vary very much. Many sores of this kind heal within a week of their formation, and never assume any peculiarities. In other cases the sores last long, have abrupt cut edges as if punched out, and show a grey surface destitute of granulations. Although they often spread at their edges to some slight extent, and closely approach the condition known as phagedæna, yet they very rarely pass into it. Phagedæna may, however, supervene, especially if the prepuce be phimosed, and the secretions pent up. With these sores there is almost invariably early enlargement of the glands in the groin. The bubo is often inflamed and the glands become matted together in one lump. There is much risk of suppuration, and large and troublesome abscesses may result. *See* Bubo. The nearer the sore to the frænum, the more certain it is that bubo will occur.

The infecting chancre may be met with on any part of the body, and has been recognised on the scalp, on the face, in the palm of the hand, and sole of the foot, on the lips, tongue, and tonsils. It is now and then multiple on the surface of the body, as, for instance, in policemen and others who have been bitten and scratched by prisoners suffering from syphilis. The non-infecting chancre, on the other hand, has never been recognised as such on other parts than the genitals. This, however, may result simply from the fact that its features are ill-marked, and we have no proof of its nature to which to appeal. Probably, also, on any other part than under the foreskin a non-infecting sore would usually soon heal. Its production and its perpetuation seem both of them to be closely connected with retention of irritating secretions.

As regards the relative proportion of infecting and non-infecting chancres, it is difficult, if not impossible, to collect trustworthy statistics. A great number of those diagnosed as non-infecting at first, assume other features at a later stage. No observer has a right to put down a sore as non-infecting, unless he has watched the case during a long period and made sure that the sore never changed its character, and that nothing followed it. It is unsafe to rely upon any local characters or their absence. If we make allowance for errors of diagnosis, and also for a not inconsiderable number in which the sores are so trivial and of such short duration that it may be doubted whether they are specific at all, it will be found that a very large majority of venereal sores are infecting. This applies, of course, chiefly to those who contract sores for the first time. A certain number of so-called 'soft sores' are such because they occur in those who, having had the disease before, are not susceptible of syphilis.

The *treatment* of chancres has been much simplified of late years. In all stages and conditions attended with suppuration and without definite hardness, iodoform is to be applied, and it will cure quickly in four cases out of five. It may be used as a powder, dusted into the sore, and, when healing commences, as an ointment, in the proportion of a drachm to an ounce of vaseline. The sores which resist iodoform usually have more or less tendency to phagedæna, and often prove for a time very difficult of cure. Iodoform is, in the first instance, to have a fair trial, the free use of warm water being also enjoined. If the sore do not heal, black-wash may be tried, or, if it assume an unhealthy aspect, the acid nitrate of mercury may be applied as a caustic. There are sores, however, which will resist all these measures, and which become healthy only when mercury is given internally. When positive phagedæna supervenes it may be necessary, in addition to the measures just mentioned, to keep the patient in a hip-bath of warm water continuously for a period of several days. *See* Phagedæna.

If a chancre show specific hardness, it is advisable at once to begin the administration of mercury, and thus anticipate and usually prevent secondary symptoms. All non-secreting indurated sores should be dressed with black-wash in preference to iodoform.

The question of the abortive treatment of chancres does not often come within the domain of practical surgery. For the most part our patients consult us too late. Some facts appear to show that the poison is imbibed early, and it avails little to excise or destroy a chancre within even so short a period as four or five days. These facts ought not, however, to hinder us from giving the patient such chance of escape as excision affords in all suitable cases. Paquelin's cautery is the best instrument to use, and with it either the sore may be burnt up in the freest possible manner, or—what is still better—a liberal excision of the structures around the infected spot may be made. Any chancre coming under the observation of the surgeon within a week of contagion, and on a part where such treatment is practicable, ought to be so dealt with.

Jonathan Hutchinson.

CHARBON. *See* Malignant Pustule.

CHARCOT'S DISEASE.—*Synonyms:* Arthropathy of ataxia; neurarthritis in connection with tabes dorsalis or progressive locomotor ataxy (Duchenne's disease). A peculiar form of arthritis, usually affecting large joints, especially the shoulder, elbow, knee, and ankle, arising in the course of the disease known as locomotor ataxia. This was first discovered and described by M. Charcot in 1868.

Cause.—The disorder is only met with in a marked form in cases of spinal tabes, and must, therefore, be regarded as directly dependent either on definite lesion of the cord, or as a part of the whole morbid state of which that sclerosing lesion forms the main or most obvious change. It is not very common, but since attention has been directed to the disorder, many cases have been brought forward in France, America, and in this country.

Pathology.—The exact nosological position of this malady is not yet determined. There is hardly any difference of opinion as to the fact that this peculiar arthritis forms part of the disorder recognised as tabes dorsalis, although some surgeons, who commonly see these cases in the first instance, are unable to detect any specific difference between them and certain cases of chronic rheumatic arthritis. It seems probable that some cases hitherto believed to be examples of hydrarthrosis have really been instances of Charcot's disease, in which the tabetic spinal symptoms were either little marked or overlooked. It must be allowed that many of the changes occurring in the affected joints are common to both morbid states. This being so, the writer holds strongly to the opinion that these changes in and by themselves, tell no complete or accurate story as to the clinical features which previously characterised the particular instance under examination. This disorder has been considered to be a new manifestation of joint-disease, chiefly for the reason that, till within recent years, no examples of its morbid anatomy have been collected and preserved in museums. The same might fairly have been affirmed of tabes dorsalis itself, and of other maladies also, till Romberg and Duchenne, by their investigations, led to its differentiation. The writer prefers to believe that it is not a new disease, but has simply been unrecognised as a specific form of neurarthritis, and that, probably, specimens illustrating it are already in museums, arranged as examples of chronic rheumatic arthritis.

Certain articular troubles have long been recognised as dependent on disease of the brain, cord, and nerves. Thus, effusion and inflammation in joints, with ankylosis, changes in the skin, œdema, &c., are regarded as sequential trophic alterations in relation to various paralyses and traumatic affections in the line of nerve-supply to the joints and affected parts. These trophic changes are attributed to damaged nerve-centres, and many of these are now known to be situated in the grey matter of the spinal cord, as, for instance, those presiding over the nutrition of muscles being placed in the anterior horns. The special centre, or centres, for the joints, if there be such, are not yet determined. The fact that in progressive locomotor ataxia the line of morbid action follows the postero-external columns (Burdach's), without, as a rule, implicating the anterior columns or grey matter, seems to militate against the view that, in this disease, the joint-affection, when it occurs, can be due to an affection of the latter. Moreover, the sclerosis may spread to other tracts of the cord, and even involve the anterior horns without inducing the specific articular affection. Some authorities, notably Buzzard, consider that a trophic centre for the joints is situated in the medulla oblongata, and some proof of this is gathered from the fact that troubles of the vagus are commonly associated, in cases of ataxia, with Charcot's joint-disease.

In most instances the affection occurs early in the course of spinal tabes, at a period between the prodromal and the ataxic symptoms. The disease may also supervene at a later stage, and is then almost constantly found in a joint of the upper limb. In relation to (1) an early and (2) a later form, it may be noted that the part of the cord affected is not always in the same region; thus, the sclerosis may begin in the higher centres, as in the medulla, and come later to affect the dorsal or lumbar portions, and *vice versâ.* Further, it is necessary to point out that tabetic patients may, like other persons, be the subject of chronic rheumatic arthritis, which runs its course as usual, presenting no special features of Charcot's disease. It has already been noted that in many of the cases examined *post mortem* all the changes recognised as the result of chronic rheumatic arthritis have been met with, and while this has been the case sometimes in certain joints, others in the same patient have presented the characters more particularly attributed to Charcot's disease. Thus, ulceration of cartilage, marginal overgrowth, dendritic, synovial, and bony growths, erosion of bone, and eburnation are found in one joint; and the results of riotous disorganisation, with fracture of bone and extreme absorption of epiphyses, are discovered in another. Hence, if morbid anatomy could testify to the pathogenic process which has been at work, there might be a fair inference as to identity in pathology of these conditions. The clinical features of the malady, however, forbid the acceptance of this view, and the furthest point of speculation here admissible, for the present, is to regard both the specific arthropathy of Charcot, and chronic rheumatic arthritis, as forms of neurarthritis.

It has been stated that no attempts at repair are seen in affected joints. This is not the case. The existence of osteophytes and of eburnation suffices to disprove this. Marginal hyperplasia is common. This is not peculiar to any form of arthritis, and is found both in gouty and rheumatic joints. Without question, the most characteristic features of Charcot's disease are the sudden onset, the extreme effusion, the rapidity of the whole process, the rapid wasting and wearing down of the bones with consequent tendency to fracture. The cases in which the disorder is of slower onset more closely resemble rheumatic arthritis. The 'benign' examples are unlike the latter in that a greater tendency exists to complete recovery from the primary local lesion which, unhappily, is too rarely witnessed in rheumatic cases.

It is important to note that other evidence of trophic disturbance sometimes occurs in the progress of tabes dorsalis. Thus, perforating ulcer of the foot is apt to occur in a small proportion of cases. Attention has also been directed to a form of arthritis involving the tarsus, sometimes with and sometimes without associated arthropathy elsewhere. To this form M. Charcot has applied the term *pied tabétique.* Disorganisation of the tarsal joints and destruction of the arch of the foot occur, certain bones may become ankylosed, and others so broken down as to be hardly recognisable, while many fragments may be found detached from them.

The relation, if there be any, between this disease and chronic rheumatic arthritis is not, at present, readily determined. An 'error of nervous force,' it has been suggested, may determine the lesion, but the method and manner of it are dependent on other causes, such as rheumatic, gouty, or syphilitic tendencies (Paget). In the writer's opinion, the phenomena of this disease throw light upon those of chronic rheumatic arthritis, the neurotic origin of which he is disposed to believe in. The life-history is essential to the determination of the nature of the morbid process in each case. In this disease the joint-changes may be the direct result of central (spinal) irritation; in rheumatic disease, there may be reflex dystrophies. The influence of the nervous system here is thought by some to be merely passive, and the changes but a result of injury inflicted upon parts whose sensibility is impaired. *See* CHRONIC RHEUMATIC ARTHRITIS.

An important point is raised by the existence of certain cases of locomotor ataxy in which no central (spinal) lesions are found, but changes are confined to the peripheral nerves. It may be that future investigations will throw light upon the latter, and that such may be found both in cases of this special arthropathy and in those of chronic rheumatic arthritis, illustrating the trophic changes in each instance. It is conceivable that, with central spinal disease, the arthritic degenerations may proceed in different fashion from that commonly occurring where no coarse lesions are present in the cord. Certainly, it is found that the affected joints can be used without pain or great inconvenience in some instances. There have been no constant lesions found in the cord or peripheral nerves in these cases. The rule is to find the ordinary affection of the columns of Burdach, but atrophy and destruction of ganglion cells have been found in the anterior cornua and in the posterolateral groups. In unilateral cases the changes have been found limited to the corresponding side of the cord; in the cervical region when the shoulder has been affected, and in the lumbar region when the knee was involved. Inflammatory changes—whether primary or secondary is not known—have also been observed in the peripheral nerves in cases of tropho-neurosis associated with locomotor ataxia. The most recent hypothesis on the whole subject has been put forward by Morrant Baker, who conceives that there may be a pathological connection between this special arthropathy, tabes dorsalis, and chronic rheumatic arthritis. He thinks that all these disorders may arise from 'some antecedent morbid state of which the result is expressed in pathological changes, sometimes in the cerebro-spinal system, sometimes in the joints, and sometimes in both.'

Symptoms.—Sudden and painless swelling in a joint, without any local premonitory symptoms, is significant of this disorder. The patient may present no sign of incoordination, but commonly has suffered from 'lightning' pains in the limbs. Pyrexia is absent. The knee is most often affected, then the shoulder, elbow, hip, and wrists, in order of frequency. The small joints are not exempted. The swelling is more or less firm, due to effusion into the synovial cavity. The integuments are not reddened, and there may, or may not, be local œdema. Some crackling may be noted at times before the extreme effusion. The '*benignant' variety* is characterised by subsidence of the swelling and return to a natural state after some weeks or months. The '*ma-*

lignant' variety leads on to rapidly degrading changes, rupture of ligaments, dislocation, fracture, and impaction of fragments of bones—a 'riotous' arthritis, in short; and all this may be set up in a few weeks. In spite of these profound changes the limb affected may retain a remarkable amount of power, movements may be freely executed and work carried on without any suffering. Portions of bone may become detached and adhere to the capsule of the joint, or osteophytes may form, and abundant dendritic outgrowths of cartilage or bone may occur within the joint. Spontaneous fracture may occur in sundry bones in some cases. The early tumefaction is not always sudden. Patients with gravely affected joints may live for many years, and retain remarkable powers of motion and capability. Thus, one man (under the writer's care) worked as a cooper's labourer for six years with hydrarthrosis and flail-like movements in both elbows, suffering no pain and little inconvenience, ataxic symptoms being well-marked at the end of that time.

The following table shows the prominent characteristics of Charcot's disease and chronic rheumatic arthritis in well-marked cases:—

Charcot's Disease.	*Chronic Rheumatic Arthritis.*
Patient not necessarily of rheumatic habit.	Patient of rheumatic habit.
Onset sudden, independent of injury, but not invariably so.	Onset gradual; often determined by injury.
First symptom: extreme tumefaction, rarely crackling.	First symptoms: slight swelling and crackling (extreme tumefaction rare and, perhaps, never sudden).
Pain absent; knee-jerks absent.	Pain severe; knee-jerks present.
Dislocation common.	Dislocation rare.
Progress: may retrograde, or disorder pass off.	Progress constant, often permanent.
Bones apt to wear away; osteophytes less marked than in rheumatism?	Much production of new bone and osteophytes.
Fragility of bones.	Condensation of bones.
Ocular symptoms.	No ocular symptoms.

It is true that instances of this disease have been noted in which it has not been possible to draw the hard and fast lines indicated above, but enough remains to show that very specific characters pertain, for the most part, to the form of arthritis which occurs only, so far as is known, in that variety of spinal tabes which induces the symptoms of locomotor ataxia. The bones are apt to become porous and fragile.

These cases have been commonly seen in the first instance by surgeons, and, hence, the special nervous symptoms associated with them, unless present in marked degree, have been apt to be overlooked. More instances have been found since the attention of surgeons has been directed to them, and, in future, it will be well to look for tabetic symptoms in all cases of monarthritis involving the larger joints. The fact that locomotor ataxia has only been clearly differentiated of late years no doubt accounts for the absence of mention of these cases by earlier writers. It is certain that the arthropathy may occur independently, or before, any active symptoms of locomotor ataxy.

Diagnosis.—This is to be made by consideration of all the concomitant nervous symptoms which may be present. These are not far to seek in most cases. The joints may be affected early, and but few indications of ataxia be found; but these are apt to supervene. The disorder is most likely to be mistaken for chronic rheumatic arthritis, and a careful review of all the symptoms, the history, the question of heredity, with knowledge of the special features of this arthropathy, will commonly avail to render the diagnosis certain. Malignant disease may be suspected in cases where the progress is rapid in an instance of monarthropathy. These disorders will be found free from the severe pain, local and reflex, and the muscular spasm which commonly accompany other forms of acute arthritis.

Treatment.—The affected joints must be set at rest. Cotton-wool, covered with light and well-adjusted bandages, should be applied. Strips of buckskin, covered with mercurial and ammoniacum plaster, and carefully applied, are useful for hydrarthrosis in any stage. Splints will be necessary in some cases to secure immobility, and casings of leather, with suitable straps, will be proper to support and restrain joints whose movements, owing to suppleness and dislocation, are too free. Remedies for the central nervous lesion must be employed, as in ordinary cases of locomotor ataxia, benefit being sometimes secured by nitrate of silver, iodide of potassium, mercury, and by cod-liver oil. Monobromide of camphor in full doses is of value for 'lightning' pains and insomnia. The disorder may altogether subside in benign cases. In the others the prognosis is bad, and the local troubles become of secondary importance as other symptoms of the constitutional malady progress. DYCE DUCKWORTH.

CHEEK, Fissure of the.—Syn.: *Macrostoma congenitum.*—This very rare deformity consists of a unilateral fissure extending from the corner of the mouth proper for some distance into the cheek, and usually continued as far as the anterior margin of the buccinator, but occasionally running upwards toward the outer angle of the orbit. The natural point of junction of the two lips is marked on each by a slight papillary elevation of the mucous membrane; but with that exception there is no difference in the condition of the parts forming the cleft from that of the lips, the inner surface being lined with a similar mucous membrane which joins the skin of the cheek, just as that which forms the red surface of the labium. The deformity is very unsightly, and gives the appearance on one side of the face of a very elongated mouth, whilst the non-union of the fibres of the orbicularis oris causes a want of expression, which is more marked when any attempt is made to smile or laugh. This unsightliness is, in many cases, increased by the presence of so-called auricular appendages or supernumerary auricles, which, however, are not always present. When they occur they are placed in front of the tragus or upon the cheek itself, in a line between the end of the fissure and the tragus of the ear, and they consist of fleshy elevations, generally containing cartilage, and covered with soft hairy skin similar to that over the helix. In shape they are small, oval, and sometimes as large as a horsebean, and are attached by a pedicle to healthy skin of the cheek, or the base of attachment may sometimes be as broad as the growth itself. They are usually bilateral, though not necessarily symmetrical in shape, or position, or number. The external ear is generally more or less misshapen on one or on both sides, and the external auditory meatus may be absent.

Causes.—The deformity is congenital, and results from a failure of union between that upper part of the first visceral arch from which is developed the superior maxilla, and the lower part of the same arch, from which Meckel's cartilage is derived, and upon which the lower jaw is formed. As the first visceral arch is visible in the human embryo at the third week, and is the earliest to unite with its fellow of the opposite side, this deformity may be regarded as a pure accident of development; and since it is found in children with elder brothers and sisters who are perfectly formed, and where no trace of similar deformity has occurred in the families of either parent, it is not hereditary, and, from the early period of pregnancy at which it must take place, maternal impressions are not likely to influence its origin.

Symptoms. — The appearances above described are unmistakeable (for portrait see paper by the writer in *Medico-Chir. Trans.*, vol. lxv. p. 20). It occurs more permanently in girls than in boys, and the subjects are often delicate. The lower jaw is frequently small and ill-developed, especially upon the side upon which the fissure exists. Besides the supernumerary auricles there are sometimes to be seen upon the cheeks of these patients small cicatrix-like striæ, or pore-like openings, ending in a *cul-de-sac.*

Treatment.—Since the condition does not cause any impediment to the power of sucking, there is no necessity to operate at a very early age, and it is wiser to allow the first year of life to pass, so that the child may be weaned and be brought into a better condition to bear the slight loss of blood incident to the operation. The child having been anæsthetised, all that is required is to make a clean incision extending just beyond the mucous surface of each lip, and to bring the cut surfaces together with two or three silver sutures, which should pass completely through the substance of the cheek and out again before being twisted together. This is preferable to the use of harelip pins, as being less likely to cause cicatrices. One stitch should be placed at the point where the two lips should naturally join, and another half-way between it and the angle of the cleft, whilst if necessary the edges of the skin may be more neatly adapted by fine sutures of horsehair or catgut. The sutures may be left for three or four days before being removed; and the wound should be dusted with a little iodoform powder, or painted with collodion to which iodoform has been added, and must be covered with a pad of lint, which should be firmly retained by strapping, so arranged as to prevent, as far as possible, any movement of the facial muscles. Every effort must be made to obtain primary union of the wound, and if this is successful the result will be found extremely satisfactory.

John H. Morgan.

CHEILOPLASTY.—Under this heading is included a great number of operative procedures of an autoplastic character, performed either for establishing an oral aperture of normal size and shape in cases of congenital malformation, or for the reconstruction of a lip that has been destroyed, to a greater or less extent, by the surgical removal of a new-growth, by malignant or syphilitic ulceration, or by the primary or secondary and cicatricial results of injury. It is proposed to deal in this article only with the latter classes of cases, as the operations necessary in cases of congenital malformation will be described under Hare-Lip; Cheek, Fissure of the.

The main object in a cheiloplastic operation is, whilst preserving a shapely and efficient oral aperture, to protect the teeth and gums, by one or more transplanted flaps of sound and healthy structures taken from the immediate neighbourhood of the defect. It is also a very important point to preserve, if possible, a free margin of mucous membrane. In most of the procedures that have been devised, each flap, after its dissection, is glided into its new position, and is not twisted. In his selection of one out of the very numerous and varied methods of cheiloplasty, the surgeon will be guided by the extent of the defect and the condition of the surrounding parts. Endeavour should be made so to contrive the dissection of the flaps that the resulting cicatrisation and retraction of the fresh wounds may tend rather to keep the flaps in their new position than to drag them away.

The simplest of cheiloplastic operations on the *lower lip* is that in which the edges of a V-shaped wound, formed by removal of a small tumour or ulcer, are immediately brought into contact by harelip pins or wire sutures.

The following are some of the best known of the very numerous operations that have been performed in cases of considerable destruction of the lower lip:—

In *Chopart's operation*, performed for covering a large rectangular defect after removal of extensive disease of the lip, a rectangular flap with its base below is taken from the chin and front of the neck, and drawn upwards over the lower jaw towards the mouth. The lateral margins of this flap are attached by sutures to the lateral margins of the primary wound, and its upper free margin forms the lower boundary of the oral aperture. This procedure is attended with several disadvantages, and its results in general have not been very satisfactory. There must be considerable tension of the flap, and it is necessary for the patient to keep the head bent forwards during the after-treatment. The flap may be dragged downwards even before the removal of the sutures. Its free labial margin, being formed of cicatricial tissue, is often very thin and uneven, and may be rolled inwards by retraction. The principle of this operation, however—that of taking the sound skin from the chin or front of the neck—has been followed, with modifications, by many surgeons, of whom may be named Lisfranc, Roux of St. Maximin, Zeis, and v. Langenbeck. Serres, of Montpellier, who was the first to propose saving the mucous membrane of the lower lip, in order to replace it on the free margin of the flap, has devised a method of inferior cheiloplasty, which, in a modified form, has been recommended by Mr. Erichsen. The object of this modified operation is, it is stated, to raise the lower lip to a level with the incisor teeth. 'An incision about three-quarters of an inch in length is made directly outwards from the angle of the mouth, on each side, into the cheek; from the extremity of this, a cut is carried obliquely downwards on to the upper margin of the lower lip so as to excise the included triangular piece; the lower lip is then dissected away from the jaw, and a V-shaped piece is taken out of its centre. By means of a harelip pin, and a point of suture on each side, the incisions in the angles of the mouth are brought accurately together; and, in the same way, the vertical one in the centre is united. If, on the removal of the diseased portion of the lip the mucous membrane has been left rather long, a good prolabium may be formed, and the restoration effected with but little deformity.' (Erichsen.)

Although a large and vascular flap may in most instances be readily obtained from the front of the neck, the tendency to retraction and sinking of this flap, and the accumulation of blood and wound-secretion in the large pouch formed below the seat of operation, render most modifications of Chopart's method less advantageous than those in which the defect is covered by lateral flaps taken from the sides of the face and brought together in the middle line. Procedures of this kind, however, can, as a rule, only be applied to cases in which the integument of the chin remains in a sound condition.

In *Syme's operation* for restoration of the lower lip, the principle of which is to leave the central part of the chin undisturbed, and to cover the defect by two lateral flaps, two incisions are made from the centre of the gap outwards and downwards to the extent of rather more than an inch, and are then carried outwards and downwards and at last a little upwards, so as to terminate on each side below the angle of the jaw. These flaps are then raised so that the two straight portions, formed in the first instance, meet together in the middle line and are united by silver sutures. The remaining extent of cut edges are united to the edges of the Λ-shaped portion of skin over the chin, which serves to support and prevent downward gliding of the flaps which form the new lip.

Buchanan's operation is applicable in cases of extensive malignant disease affecting the upper part of the lip, and leaving the chin quite free. From the centre of the inferior curved margin of the wound, made on removing the disease, two straight incisions, one on each side of the median line, are carried downwards and a little outwards. From the lower end of each of these incisions a long and but slightly curved incision is made in a direction outwards and upwards. The two oblong flaps thus mapped out are dissected from the subjacent parts and then raised upwards, the upper curved margins forming the margin of the lip, and the short inner margins of its flaps coming into contact in the median line, where they are connected by sutures. The triangular wound left below each flap is allowed to heal by granulation.

In *Teale's operation* for severe cicatricial deformity of the lower lip from burn, the everted lip is divided into three parts by two vertical incisions, each three-quarters of an inch in length. The width of the middle portion found between these two incisions should equal half the width of the lip. From the lower extremity of each of the vertical incisions, a curved incision is next to be carried upwards and outwards to a point about one inch from the commissure of the lips. The two lateral flaps are then dissected up, and raised and united by sutures in the middle line above the middle flap, to the freshened upper margin of which their lower margins are also fixed by sutures.

Other operative procedures for the reconstruction of the lower lip by the formation and apposition of lateral flaps, have been devised by Malgaigne, Dieffenbach, Bruns, and Szymanowski.

In a case of very extensive destruction of the lower lip, and of the soft parts of the chin, it might be possible to perform a satisfactory cheiloplastic operation by applying Reid's method, taking, in the first place, a single flap from the skin of the neck, and subsequently bringing together, above this, two lateral flaps.

Cheiloplastic operations on the *upper lip*, performed mostly in cases either of congenital malformation or cicatricial deformity, consist in varied applications of the double lateral flap method. In *Bérard's operation* each flap is formed by one incision, carried from the upper extremity of the defect outwards through the soft parts of the cheek, and a second, parallel to this, commencing at the corresponding angle of the mouth. This procedure has been modified by Bruns, who, at the outer end of each upper incision, excised a triangular piece of skin with the apex upwards, and at the end of each lower incision a similar piece of skin with the apex downwards. Dieffenbach formed his lateral flaps by a curved incision on each side round the ala of the nose. Teale also performed a cheiloplastic operation on the upper lip by making two crucial incisions, the intersecting point of which was placed in the median line, just below the septum nasi. The two lateral triangular flaps thus formed were drawn inwards, one below the other, and retained in this position by twisted sutures. Other plans of superior cheiloplasty, on the same principle of lateral flaps, have been devised by Malgaigne, Mirault, and Sédillot.

W. Johnson Smith.

CHELOID. *See* Cicatrices, Pathological Conditions of.

CHEMOSIS. *See* Conjunctiva, Diseases of the.

CHEST, Deformities of the. *See* Caries of the Spine; Pigeon-breast.

CHEST, Injuries of the.—*General Diagnosis of.*—These injuries may be divided into:—(1) those presenting some external wound; (2) those without external wound.

1. This class may be again subdivided into wounds of the parietes alone, and penetrating wounds which affect the structures within the walls of the chest also.

The diagnosis of wounds of the external parietes alone will be mostly negative. The external wound may pass in a direction in which it is impossible that the chest contents should have been injured; and again there will be a total absence of the severer symptoms usually associated with injury to the contained viscera. The worst symptoms which such a wound presents are due to division of large parietal blood-vessels or nerves, or injury to muscle. Thus we may have a blood-tumour form beneath the integument or the muscle, as the immediate result of the wound; or, later on, suppuration may take place in the track of the injury, either under the muscles or directly beneath the skin and fascia.

When the structures within the thorax have been injured, the symptoms will be of a severer character. The pleura may fill up more or less with blood, forming a Hæmothorax. Or air may enter its cavity, either from the external wound or from the wounded lung, forming a Pneumothorax. Or, finally, suppuration may take place in the cavity, constituting an Empyema.

If the lung itself be wounded there will be effusion of blood into its substance, followed by inflammation, which may spread extensively, so that a very considerable part of the wounded lung may pass into a state of acute Pneumonia. This state is indicated at first by the expectoration of florid blood (hæmoptysis), and afterwards by the signs of consolidation of the lung, as shown by dulness on percussion, by rust-coloured expectoration, bronchial breathing and bronchophony; these latter signs may be much concealed by blood or fluid in the pleura in those cases in which there is much present. In either case, the burden of respiration will be thrown principally upon the uninjured lung, and there will be great dyspnœa and impeded circulation, as may be evidenced by blueness of the face, lips, &c. Percussion will give a dull note over the injured side (except in cases of pneumothorax), and auscultation will show the absence of efficient breathing. The temperature at first is somewhat depressed from shock, but later on may become elevated, especially if suppuration sets in. The diagnosis may be somewhat aided by the direction of the wound. In these cases it is not wise to permit much probing, but the direction of a wound can often be ascertained by collateral circumstances; and if these are absent, light and careful probing, not prolonged, will often sufficiently indicate the general direction of the wound, and show that some of the internal structures must have been damaged.

If the Heart or Pericardium be wounded (and the one rarely occurs without the other), the symptoms are of the gravest character. Immediate death not infrequently follows, and, in those cases in which life is prolonged, recovery comparatively seldom takes place. Should life be prolonged, however, the signs of such an injury will consist in trouble to the circulation, from the impeded heart's action, a quick, small, laboured, and intermitting pulse, dyspnœa, and blueness of the face and extremities. The wound itself is attended by a sharp burst of hæmorrhage, which, however, speedily ceases as the external aperture becomes closed. The bleeding then takes place into the cavity of the pericardium, giving rise to the impeded circulation spoken of above, or into one of the mediastinal spaces, the signs of which are much more obscure. Auscultation of the heart does not give so much assistance as might be expected, but the precordial dulness is often increased. The heart-sounds are inaudible or scarcely audible, from the blood in the pericardium obscuring their distinctness, or if the amount of blood be very small, as in those rare cases where the pericardium is alone wounded and the heart has escaped, the friction-sound of pericarditis may be audible.

Penetrating wounds belonging to this class are sometimes complicated by foreign material, carried into the interior by the agent inflicting the injury. This is palpably the case in gunshot wounds, where a bullet is left in the chest. The same lesion exists when a portion of clothing is carried into the wound by a bullet, or, less frequently, by a stab. The diagnosis of this state will always be made with great difficulty, unless the foreign material can be seen or felt, though its presence will militate immensely against the chance of the patient's recovery. Not less dangerous, though much less palpable, is the foreign material carried in from without by a dirty weapon. This not infrequently gives rise to a poisoned wound, leading to the death of the patient from septicæmia.

2. The injuries to the chest without external wound comprehend fractured ribs, sternum, &c., and lacerations of the muscles, and also those cases in which the thoracic viscera have been damaged, either by compression from the injury or by a fractured end of bone having been driven into them. These cases will be treated of in separate articles, but it may suffice to state here that the general symptoms are similar to those in Class 1. When, however, the Lung is injured, general Emphysema is often superadded to the symptoms before enumerated, but Pneumothorax is of less frequency, the air escaping directly into the general cellular tissue more often than into the cavity of the pleura. The diagnosis of this state is at once made by the swollen puffy state of the integuments, and by the crackling sensation communicated to the fingers on pressing them over the swollen part; this crepitant feeling is due to the air being squeezed from one part of the areolar tissue to another.

When the pericardium is wounded by the fractured end of a rib or of the sternum, the heart more frequently escapes injury than where there is an external wound. This injury is therefore of a less severe character, and may be recognised by the increased precordial dulness arising from the cavity of the pericardium being dilated with inflammatory effusion, or by the friction-sound which indicates the existence of pericarditis. H. G. Howse.

CHIGOE.—The parasite (*Pulex penetrans*, or sandflea) which causes this disease is one of the pests of the West Indies and some parts of S. America. While both male and female live in the sand, it is the latter which, when impregnated, makes its way under the nails or between the toes of the human foot, where its presence is made known by the appearance of a white pea-like vesicle, which leads to much itching and irritation.

Treatment.—The orifice of entrance is to be carefully found, and skilfully dilated with a needle, and the vesicle then turned out whole. Great care must be taken not to rupture the vesicle, otherwise the escape of the ova into the soft parts will lead to most troublesome suppuration.

W. H. A. Jacobson.

CHILBLAINS are localised erythematous congestions, usually met with on the toes and fingers of weakly subjects, and liable to inflammation and even ulceration from time to time. The patients affected are usually children, more frequently girls, who take insufficient exercise and who are allowed to hang much over the fire before going out, or return to it immediately on coming in. It is rare to meet with chilblains after adolescence, though occasionally they are seen in grown-up women. The usual sites are the feet, hands, and not uncommonly, to a lesser degree, the ears, or much more rarely, the nose.

Chilblains will be met with in the following conditions : (*a*) red swollen patches liable to congestion, especially after going to the fire, taking food, or when first taking exercise ; and when congested, itching, pricking, or tingling most intensely. (*b*) After frequent attacks of congestion the chilblains become more swollen, tender, and covered with vesicles. (*c*) The vesicles break and leave raw excoriated surfaces, liable to pass into very troublesome ulcers. It is rare to see chilblains go beyond this third stage, though occasionally the ulcers they cause become sloughy or even gangrenous.

Treatment.—In the treatment of chilblains the chief aim of the practitioner must be to stimulate the weakly circulation both locally and generally. To begin with, tight garters or boots should be forbidden, and only those worn which admit of warm socks or stockings. Regular exercise daily, especially in cold weather, should be insisted on, patients liable to chilblains being too often kept indoors; hanging over the fire before and after going out is especially to be forbidden. A chilled sponge bath in the morning, followed by good friction, this being repeated before a fire at night, so as to send the patient to bed in a glow ; improvement in the diet as well as the addition of meat or its equivalent at breakfast, a glass of port wine or half a pint of milk with f℥ss. of rum in it at 11 a.m. and a course of bark and acid if need be, are all points of importance. So, too, at night the bedroom should be warmed, and knitted ' bed boots ' worn, scarcely anything being more likely to conduce to or maintain chilblains than the custom of sending weakly children from heated sitting rooms into chilly bedrooms.

Locally, as long as chilblains are unbroken the treatment should be directed to judicious stimulation of the part. Thus, frequent bathing should be made use of in cold or just chilled salt water, or in water to which mustard has been added, the bathing being followed by persevering friction with a soft towel or flannel. The following stimulating applications will be found useful in the earlier stages. One part of Tr. iodi to two of Lin. saponis gradually increased to equal parts ; one part of Tr. cantharidis to six of Lin. saponis ; camphor dissolved in eau de Cologne, or equal parts of turpentine and olive oil. Nothing relieves the intolerable itching better than the Linimentum belladonnæ painted on and allowed to dry, or the application of Papier Fayard. Another application, which is only to be used where the chilblains show no sign of breaking, is aconite, opium, and chloroform liniments āā f℥ss., to be well rubbed in night and morning with soft flannel. Where vesication has taken place, flexile collodion, or the anodyne amyl-collodion will be found useful. In the stages of ulceration or sloughing, treatment appropriate to those conditions must be adopted.

As regards internal remedies, probably small and repeated doses of opium are the most trustworthy. W. H. A. Jacobson.

CHILDHOOD, the Surgical Affections of, are special only in the sense that they occur in children ; for with very few exceptions children are liable to the same diseases and accidents as adults. Any peculiarities, which disease manifests when occurring in childhood, depend not on special types of disease, but on certain physiological differences which distinguish the juvenile and adult periods of life. CHILDHOOD extends from birth to the thirteenth or fourteenth year of life. The first twelvemonth of this period is the *period of infancy*; the last year or two border on the age when *childhood* gives place to *adolescence*. The former is characterised by an excess of animal over intellectual growth, the latter is the period when intellectual activity begins to assert itself over mere bodily growth, and when the organs undergo higher development and not merely increase in size. These facts not unnaturally influence the nature and course of any disease which occurs at the several periods named. The bodily TEMPERATURE of young children is rather higher than that of adults, and it is more easily disturbed. Thus in children's hospitals the temperature of the majority is found to rise after the parents have left on visiting days. Little articles of diet surreptitiously brought in no doubt must be credited for something, but it is chiefly the mental effect on the children which causes this rise. So, too, after accident or operation: the temperature, therefore, is not quite so reliable a guide as in adults, and variations mean less than with them. On the other hand, children are more susceptible to changes in the external temperature than adults, and great care is necessary with regard to this point; the temperature of the sick room should be kept at a uniform point night and day, and some five to ten degrees higher than for adults. Infants are peculiarly susceptible to cold, and not a little infantile mortality is due to too low a temperature, especially during the night, when the physiological functions are at their lowest ebb. Errors are more likely to be prejudicial if the temperature of the room has been kept up during the day.

The question of SHOCK is one of the first which occurs to the surgeon's mind, when he is called to a severe accident, or when he has to decide on an operation. It is usually asserted that children more readily succumb to shock than adults. In the writer's opinion this is not the case. The intense vitality of children, the integrity of their vascular and emunctory systems, the absence of unfavourable psychological influences which so beset adults, are factors of the greatest moment all in their favour; and the success which has attended even such severe operations as abdominal section, ovariotomy, extirpation of the kidney, and many others, are testimonies in favour not only of a child's endurance, but of its great recuperative power. A matter of great importance after operation or accident is the assuaging of pain. PAIN is very exhausting, and children do not bear pain so well as adults. It is owing doubtless to the saving of pain by chloroform—which children take better than any other anæsthetic—that so little shock is observed after severe operations; and if opium in full (proportionate) doses be afterwards administered to save subsequent pain, shock can be largely banished from children's surgery. The writer gives one minim for each year of life, and one for the operation; thus for a child three years old, four minims of the tincture of opium would be given after a painful operation.

HEREDITY plays a very important part in the causation and type of disease in early childhood: the worst effects are usually found in organs which are most rapidly developing. As age progressively advances, and as a child's tissues, so to speak, become more and more independent of their ancestry, hereditary influences gradually weaken. Thus, an infant born with congenital syphilis almost invariably suffers within the first few weeks of birth—the stronger the hereditary taint, the more severe will the disease prove in the child, and the earlier will it manifest itself, and *vice versâ*. In regard to those changes which we call strumous, they tend gradually to pass away as age advances, under suitable treatment and surroundings; hence in the treatment of the lesser manifestations of this diathesis it is highly important to gain time; so, too, in prognosing as to strumous lesions, either of the glands or of the joints, or elsewhere, provided ordinary care be exercised, time itself will frequently bring about a cure. Many a joint may be saved from excision by expectant treatment, if directed to the general as well as to the local condition, and patiently persevered in.

CONSTITUTIONAL PECULIARITIES greatly modify the growth of a child. Rickets, for instance, may manifest itself by no other visible sign than that of retarded, stunted growth, so that 'backwardness' in children is often synonymous with rickets. It is important to recognise this fact, for cod-liver oil, and shampooing the limbs with sea-water, will often work marvels in a comparatively short time.

Much more than in adults, INJURIES in children tend to bring out constitutional peculiarities; a syphilitic or rheumatic taint will often remain latent until an injury calls it forth. Thus strumous affections are often traceable to a slight injury. Acute tuberculosis, especially of the brain, is often set up by a fall or blow on the head. Disease of joints follows slight wrenches or blows, such as would be inoperative in a strong constitution. After operations and accidental (open) injuries, children sometimes get scarlet fever, and occasionally other similar diseases. In the same manner a general eczema may be set up in children predisposed thereto by very slight external irritants—rough flannel, coarse soap, flea-bites, slight scalds, or the use of strong external applications. In certain but few cases vaccination is followed by a general and troublesome eczema, which is due to the irritation set up by rubbing the vesicles, or even of unskilfully taking out lymph.

In infants, those parts are chiefly liable to take on disease or disordered function which have been latest perfected, or those which are still in a condition of active development. Hence HERNIA is exceedingly common in infants: the tunica vaginalis testis has been so recently shut off from the general peritoneal cavity, or but imperfectly shut off, that a very slight cause is sufficient to open it up again. The commonest cause is tight bandaging. Mothers and nurses think it supports a child's abdomen to keep it tightly swathed in a flannel binder. The practice is a bad one, for it does not allow for changes in size of the abdomen, due to flatulence or to the ingesta, and the intestines pass into the scrotum, reopening the hardly closed abdominal rings for the purpose. In a large percentage of cases, the removal of the tight bandage allows Nature to reassert herself, and spares the child the discomfort of wearing a truss. Another very troublesome affection of early life, connected with development and growth, is acute EPIPHYSIAL DISEASE. Its commonest cause is congenital syphilis, but it also occurs in other cachectic subjects; it results too from, or is apparently started by, slight injuries in children not manifestly the subject of specific disease. This liability to disease at the epiphysial junctions lasts all through childhood; but as age advances, the disease, when it occurs, assumes a more chronic form. Slight injuries, which would be otherwise harmless, suffice to set up disease in these parts, on account of the great physiological activity which is taking place. In estimating obscure injuries about the joints of young persons, the epiphysis and its possible participation in the condition should always be borne in mind. The BURSÆ in connection with the muscles surrounding joints—the hip-joint especially—are liable on slight provocation to enlarge and suppurate. In opening these, it should be remembered that they are frequently connected with joints and may involve them in suppuration.

The developmental activity of childhood predisposes to MORBID GROWTHS; hence the frequent occurrence of tumours, in the immediate causation of which injury seems to take a considerable share. Excluding the congenital tumours (which are generally either cystic or fatty), the most common is sarcoma; of this it may be said that the younger the patient, the greater its malignancy, and the greater the need for early and radical treatment.

In the *Treatment* of all affections of children, it is highly important to remember the possibility of a mixed diathesis; thus syphilis and struma may exist in the same child, and be about equally balanced; the writer has seen many such cases, in which, for instance, mercury alone has failed to cure a child of its congenital syphilis; but when combined with cod-liver oil has been quite successful. On the other hand, cod-liver oil in strumous children is often greatly aided by a judicious use of some mercurial. Syphilis and rickets also frequently coexist. Success in treatment will depend on the combined use of those drugs which are known to influence the diseases—more or less of the one or the other being given in proportion as one diathesis appears to predominate over the other. Treatment should always be continued for some time after the local injury or disease has subsided; for the constitutional element remains present, ready to assert itself on the slightest provocation.

As regards *drugs*, whether for internal or external use, it may be said that children are a little more susceptible to their influence than adults. Opium especially is thought to affect children more readily than adults; on the other hand, children tolerate both mercury and belladonna better than adults. Mercury especially they bear in full and long-continued doses without ill-effects, probably owing to the large amount of milk they take, which deprives it of its irritant effects. There is the same individual susceptibility to drugs which is met with in adults. In prescribing, therefore, it is wise to commence with small doses, and repeat them until the desired physiological effect is produced.

ROBERT WILLIAM PARKER.

CHIMNEY - SWEEP'S CANCER. *See* Scrotum, Injuries and Diseases of the.

CHLOASMA. — This name is now given to circumscribed hypertrophy of pigment in the skin, occurring in large patches, and also to diffused increase of pigmentation due to a variety of causes; the term melasma or nigrities is applied when the increase is so excessive as to give the skin a very dark, nearly black, colour.

Causes.—Exposure to the sun produces the well-known hypertrophy called sunburn, and people who are fond of sitting much before the fire are apt to get reticulated pigmentation over the shins (*Chloasma caloricum*). The application of irritant substances to the skin, such as blisters and mustard plasters, is very frequently followed by an increase of pigmentation, which is sometimes permanent (*Chloasma toxicum*). Again, mechanical irritation of the skin by rubbing and scratching, as by the pressure and friction of tight bandages, and scratching to relieve intense itching, as in prurigo and phthiriasis, will give rise to pigmentation (*Chloasma traumaticum*). Further, any disease of the skin which is accompanied by long-continued hyperæmia, especially if itching be superadded, is commonly followed by pigmentation; thus scabies, eczema, psoriasis, lichen planus, are often succeeded by increased pigmentary deposit. It is obvious that all the above-enumerated forms have one important factor in common, and that is hyperæmia of the affected skin as an antecedent; whether this be due to heat and exposure, to chemical or mechanical irritation, or to disease. They may therefore be logically grouped together as varieties of pigmentation due to direct affection of the skin, or *Chloasma idiopathicum.*

Increased pigmentation of the skin also occurs in connection with physiological and pathological processes which affect the whole system, without directly implicating the skin; the affection is then called *Chloasma symptomaticum.* Pregnancy constantly gives rise to pigmentation of the face, neck, nipples, and linea alba (*Chloasma gravidarum*), while the most various diseases and functional disorders of the uterus and ovaries are accompanied in many cases by a similar affection (*Chloasma uterinum vel hepaticum*). This variety is met with chiefly on the face, especially the forehead and temples, as smooth patches of variable size and shape, circumscribed or diffused, and varying in colour from yellowish to a liver-coloured, deeper brown, or smoky tint; it sometimes extends to the neck, backs of hands, and trunk; it usually subsides on removal of the uterine or ovarian condition on which it depends. Strong mental emotion, especially fright, and various functional affections of the nervous system must be mentioned among the causes of increased pigmentation. It occurs also in various chronic exhausting diseases (*Chloasma cachecticorum*); it is often well-marked in the cachexia of cancer, inherited syphilis, malaria, phthisis, and scrofula, and in a lesser degree in Bright's disease and myxœdema.

But the most striking kind is the bronzing of the skin which occurs in Addison's disease (*Melasma suprarenale*); this is most strongly marked on exposed parts, as the face, neck, and hands, and varies in tint from the yellowish-brown of sunburn to a deep greenish-brown colour; the nipples, axillæ, and genitals are often so strongly pigmented as to be nearly black; the pigmentation is diffused, but patches of a deeper tint occur here and there on the brown skin, and pigmented spots are also found on the mucous membrane of the mouth and elsewhere.

In a few cases of generalised melanotic sarcoma, the skin, especially of the face and hands, has been noticed to assume a slaty colour. Syphilis occasionally gives rise to pigmentation of the skin apart from that which is so constantly met with as following syphilitic eruptions. This affection, which has been chiefly described by French authors under the name 'Syphilide pigmentaire,' is met with almost exclusively in women in the secondary stage, chiefly on the neck, where it forms a reticulated blotching of a light coffee-colour. It is sometimes more extensive, and has now and then been found in males. As it is met with when all other signs of syphilis are absent, and is quite uninfluenced by treatment, it is probably to be viewed as a form of chloasma. It should be noted, however, that several observers look upon the discoloration as due, in great measure, to atrophy of pigment in the parts enclosed in the brown meshes, and therefore class it with leucoderma.

The differential diagnosis of chloasma is not difficult; practically the only disease with which it may be confounded is tinea versicolor; but this occurs chiefly on the trunk, never on the face, is slightly scaly, especially on scratching with the finger-nail, and nearly always itches; whereas chloasma is commonest on the face, has a smooth surface, and does not itch. Microscopical examination of the detached scales of tinea versicolor, after treatment with potash, shows the characteristic fungus, which is of course absent in chloasma. A simple method in a doubtful case is to paint the surface with a weak solution of iodine; this gives an intense reddish-brown tint in tinea versicolor, but no darkening in chloasma.

As chloasma depends upon the deposition of increased pigment in the epidermis, treatment can only be of service by removal of the affected cuticle; therefore all substances which cause desquamation are of value. The best of these is corrosive sublimate, which may be employed as a lotion of about one grain to the ounce; but an ointment of white precipitate or sulphur, or painting with iodine, will also be efficacious, although not so active. For congenital excess of pigment, *see* MOLE.

JOHN CAVAFY.

CHLOROFORM. *See* ANÆSTHETICS.

CHOLECYSTOTOMY is an operation which consists in opening a dilated gall-bladder through an abdominal incision, for the removal of impacted calculi.

The presence of *biliary concretions* does not, as a rule, give rise to any urgent symptoms beyond those due to occasional attacks of so-called biliary colic, caused by the passage of a gall-stone through the ducts. Cases are even met with *post mortem* where the gall-bladder is found completely packed with closely wedged calculi, of which no indication had existed during the patient's lifetime. Occasionally, however, the presence of such concretions may lead to inflammation of the gall-bladder, followed by suppuration and the ultimate discharge of its contents through an opening in the abdominal wall, resulting in the formation of a biliary fistula.

DILATATION OF THE GALL-BLADDER, consequent upon obstruction of its duct by an impacted calculus, is a somewhat rare affection, more commonly met with in women than in men. The retained fluid, consisting of bile mixed in greater or lesser proportion with mucoid secretion from the lining membrane of the gall-bladder, may occasionally become purulent as the result of inflammation of the sac. The distension, if long unrelieved, exposes the patient to the risk of sudden rupture of the dilated bladder —an accident almost inevitably followed by fatal peritonitis.

Symptoms.—1. *Recurrent paroxysmal attacks of colic*, referred to the right hypochondrium, and thence radiating through to the back and loin as well as downwards towards the thigh, are usually the first indications of the impaction of a gall-stone. The pain, which is commonly very severe, and accompanied by retching or vomiting, is from the first readily induced by exertion of any kind. As the dilatation progresses it becomes, however, more or less constant in character, while subject always to recurring paroxysms. 2. *Jaundice* is not a common symptom of gall-stone impaction obstructing the *cystic* duct. Its presence in any case would indicate closure of the *common* duct, a condition which, if unrelieved, usually proves fatal before the occurrence of any marked dilatation of the gall-bladder. 3. *Formation of a tumour in the right hypochondrium.*—The fundus of the normal gall-bladder projecting below the margin of the right lobe of the liver opposite the ninth costal cartilage, lies beneath the outer border of the right rectus muscle, and its tendency when enlarging is to project downwards and forwards towards the umbilicus. A *dilated gall-bladder* usually constitutes a somewhat pear-shaped or semi-globular tumour, overlapped by intestine along its lower and inner borders. When of moderate size, its shape and free mobility may occasionally lead to its being mistaken for a movable kidney. It is commonly smooth on the surface and of uniform contour, either firm or elastic on palpation, according to the degree of distension, and often the seat of much tenderness, especially after being handled.

Diagnosis of the affection during its early stages is often a matter of considerable difficulty, unless a well-marked history of the passage of gall-stones on previous occasions be obtainable. In any given case the following conditions may require elimination before arriving at a definite conclusion:—1. Malignant disease of the liver, of the gall-bladder, of the stomach, omentum, or pancreas; 2. Abscess in or about the liver; 3. Hydatid disease; 4. Renal tumours, solid or fluid; floating kidney; 5. Dermoid or ovarian cysts. *Aspiration* of a cystic tumour suspected of being a dilated gall-bladder, although useful as a means of diagnosis, especially with a view to detecting the presence of calculi, is not altogether devoid of risk, from the possibility of the subsequent escape of irritating fluid through the cyst-puncture—an accident which may well lead to disastrous consequences, should the swelling prove to be due to hydatid disease. A small *exploratory incision*, if carried out with all due antiseptic precautions, is a much more satisfactory and safe proceeding in doubtful cases.

The operation of Cholecystotomy is performed as follows:—A vertical incision two inches in length, commencing about an inch and a half below the costal margin, is made over the tumour along the outer border of the right rectus muscle. All hæmorrhage should be arrested by pressure-forceps before opening the peritoneum, which is to be freely divided to the same extent as the skin. The surface of the tumour having been thus exposed, the surgeon next introduces one or two fingers for the purpose of ascertaining its connections and detecting the cause of obstruction. Sponges are now inserted around the incision to protect the peritoneal cavity, and the gall-bladder is evacuated by means of the aspirator. Before the canula is withdrawn, the now flaccid cyst should be seized by pressure-forceps applied above and below the seat of puncture, and drawn well forward through the abdominal wound. Its wall is then incised vertically to the extent of one inch, and the sides of the opening are held apart by forceps while the interior of the sac is sponged out dry. Introducing his finger, the surgeon feels for an impacted calculus, and, if possible, removes it with the help of suitable forceps. Should he be unable to grasp the stone, an attempt may be made to dislodge it by external manipulation through the wall of the duct, or, failing this, it may be crushed from without by means of carefully-padded forceps, the fragments being afterwards squeezed onwards through the duct, or back into the gall-bladder and thence removed. Finally, the condition of the ducts should be thoroughly explored, in order to make sure that no obstruction remains.

A rubber drainage-tube is now inserted in the gall-bladder, and the abdominal incision is closed around it by sutures which must include the edges of the divided peritoneum, together with those of the opening in the gall-bladder. A carbolised sponge is placed over the end of the tube, and an antiseptic dressing is applied over all. The discharge of bile is usually very profuse for the first thirty-six or forty-eight hours, after which it gradually lessens in amount. The sutures may be taken out at the end of a week, but the tube should not be removed until all discharge has practically ceased. The fistulous opening left by it usually heals of itself in the course of a few weeks; but, failing this, it may be readily closed by operation.

Another plan of treatment, which was adopted in one case by the writer, consists in closing the gall-bladder incision, after removal of the calculi, by means of a continuous silk suture involving only the muscular and peritoneal coats; the sac is then dropped in, and the abdominal incision is closed in the usual way. The objection to this procedure *without drainage*, lies in the fact that it may not be always possible to make quite certain that all obstruction has been removed at the time of operation; for, if such be not the case, the rapid accumulation of bile or mucus might tend to force open the incision in the gall-bladder, and thus allow of the escape of its contents into the peritoneal cavity.

A further modification of the usual operation, proposed by Dr. Gaston of Atlanta, U.S.A., with a view to obviate the dangers of an unrelievable obstruction of the *common* duct, aims at the establishment of a permanent artificial communication between the gall-bladder and the duodenum. It is conceivable that the procedure suggested might prove useful in certain exceptional instances, but so far its value has not been tested in the human subject.

Cholecystectomy. — *Excision of the dilated gall-bladder* has been advocated by Prof. Langenbuch of Berlin. The operation, however, apart from the immediate risks entailed by its performance, does not necessarily ensure restoration of patency to the *common* duct, and cannot therefore be said to afford any advantage over the more usual method of treatment in these cases.

William Appleton Meredith.

CHOPART'S AMPUTATION. *See* Foot, Amputations in the.

CHORDEE. — In the acute stage of gonorrhœa the patient usually suffers at night, when in bed, from frequent attacks of very painful erection, with bending and slight twisting of the penis. The concavity of the arc is almost always directed downwards, but some few instances have been observed of lateral and also of upward bending. This condition is the result of acute inflammation along the urethra and of general congestion of the penis. The erections are excited by irritation of the prostate, and the associated pain is due to the congested and engorged condition of the penile spongy tissue. The walls of the urethra, together with the peri-urethral tissue, and more or less of the corpus spongiosum being stiffened in consequence of inflammatory deposit, become far less extensile than the other structures of the penis, and so, as the corpora cavernosa become distended, yield but in a slight degree.

This, which is the generally accepted view as to the causation of chordee, has been opposed by Mr. Milton, in whose opinion the bending of the penis is due to spasm of the special muscular elements of the urethra.

For the treatment of chordee, see GONORRHŒA.

CHOROID, Diseases of the.—The choroid is a vascular membrane which lines the posterior part of the eyeball, as far forward as to the margin of the ciliary body (q. v.), and is interposed between the retina and the sclera. It is perforated for the passage of the optic nerve, and is loosely attached to the sclera by a very slight connective tissue until it reaches the ciliary region, where, as well as in the immediate neighbourhood of the nerve-entrance, the connection between the two structures is closer and more intimate. The choroid consists essentially of a web of blood-vessels, which are coarser and larger on the side turned towards the sclera, and capillary on the side turned towards the retina. The principal veins of the choroid are arranged in a series of whorls, called *vortices*, five or six in number, the veins of each vortex running to a common centre, and there uniting in a single vein, which passes out of the eye through an oblique channel in the sclera. Internal to the vortices there is a layer of vessels of smaller size, and internal to these there is the so-called *chorio-capillaris.* The intervascular meshes of the membrane contain a variable amount of pigment, usually of a dark chocolate-brown colour, and between the chorio-capillaris and the perceptive layer of the retina there is a layer of pavement-epithelium, the cells of which, in dark eyes, are loaded with pigment to such an extent that the layer is rendered practically opaque, and conceals the choroidal structure from ophthalmoscopic examination. This layer of pigmented epithelium was formerly described as part of the choroid, but most modern histologists refer it to the retina. By its intermediation, the two membranes are in intimate union with each other, and the perceptive layer of the retina derives its nourishment from the chorio-capillaris. Besides connective tissue, blood-vessels, and pigment, the choroid contains many filaments derived from the short ciliary nerves, and the long ciliary nerves pass forward between it and the sclera until they approach the ciliary region. In man, the choroid has, presumably, no other function than to provide for the nutrition of the retina, and to convey vessels and nerves to the ciliary body and iris, but in some of the lower animals it is comparatively more voluminous, and in many birds it projects into the cavity of the eyeball in a large fold called the *pecten.* There is reason to believe that, in such conditions, it ministers to accommodation by permitting considerable variations in the quantity of blood which is contained within the eye at different times.

Ophthalmoscopy.—Our knowledge of the diseases of the choroid is derived chiefly from the ophthalmoscope, and hence the normal aspect of the membrane is the first point which requires description. This aspect depends entirely upon the amount of pigment which it contains. In the dark races, and even in dark Europeans, the choroid itself is invisible, being completely screened from view by the layer of pigmented epithelium, which presents a uniform dark brownish-red surface, broken by the comparatively white circle of the optic disc, and seen through the slight opalescence of the retina. In Europeans, with brown or hazel eyes, it is seldom possible to see choroidal vessels. In them the membrane forms a red, or orange-red, background, against which the retina itself is scarcely visible, although the arborescent ramifications of its blood-vessels are conspicuous. As seen in the direct method of ophthalmoscopic examination, the choroidal background assumes a finely granular appearance, and the optic disc is often bordered by a crescentic line, or even by a complete circle, of pigment, which appears almost black by contrast. In very light eyes, pigment is comparatively absent, both from the epithelial layer and from the choroidal tissue, and in such conditions the latter is conspicuous. The vessels of the choroid are distinguished from those of the retina not only by their situation on a deeper plane, but also by the manner of their arrangement. The retinal vessels are arborescent in their distribution; the larger vessels of the choroid, which form radii to the centres of the vortices, are almost parallel to one another. In very light eyes, the inner surface of the sclera is visible through the meshes of the choroidal vessels, which then evidently rest upon a white background.

In certain morbid conditions the pavement epithelium of even dark eyes loses its pigment, and exposes the choroidal tissue to view. When this occurs, the parallel vessels are seen to be separated by more or less linear interspaces, which are filled by the loose pigment of the choroidal stroma, and hence appear dark by comparison with the vessels. The resulting striation, which is manifestly behind the retina, and over which the retinal vessels pursue, independently, their arborescent course, presents a very curious and interesting picture.

The vessels of the retina are chiefly contained in the anterior layer of that membrane, which consists essentially of nerve-fibres and connective tissue. Between this layer and the choroid other retinal layers are interposed, which consist essentially of nervous elements, with but little connective tissue, and which scarcely at all modify the ophthalmoscopic image. When the retina itself, or rather the connective tissue of the fibre-layer, becomes the seat of morbid changes, these must inevitably, in some degree, conceal the retinal vessels from view, and, conversely, when the retinal vessels are plainly visible, the retina itself must be free from disease. Hence, when there is any morbid appearance in the fundus of the eye, and when, across and in front of this morbid appearance, between it and the spectator, the retinal vessels pass in an unchanged condition, the inference is inevitable that the appearance is posterior to the retina, or, generally speaking, that it is in the choroid. The chief exception to this statement is furnished by the disease commonly described as 'pigmentary retinitis,' a disease which affects chiefly the contiguous layers of the retina and choroid at their surfaces of apposition, and which, in the writer's opinion, should be classed among choroidal affections rather than among those of the retina.

A patch of inflammation in the choroid is liable to produce two marked changes, obliteration and atrophy of the blood-vessels of the affected area, and displacement of its pigment. These changes produce transparency of the tissue, and hence render the sclera plainly visible. The seat of a localised choroiditis will usually be left as a white spot, surrounded by a narrow black border. The whiteness is that of the inner surface of the sclera, and it will sometimes be broken or diversified by remains of the original choroidal stroma. The black border consists of displaced pigment, which has infiltrated the ring of tissue immediately around the inflamed structure.

Pathology.—The anatomical position and relations of the choroid render it liable to become implicated in morbid changes which originate in other tissues. It not infrequently participates in inflammations of the sclera at the two regions where it is in close union with that structure, and we then have the conditions which have been described under the names of 'sclero-choroiditis anterior' (*see* CILIARY BODY, Diseases of the), and 'sclero-choroiditis posterior' (*see* REFRACTION, Errors of). It is prone to participate in iritis, which may extend to it by direct contiguity, constituting irido-choroiditis. It is still more prone to participate in cyclitis. It is early involved in that general plastic inflammation of the eye which is called sympathetic ophthalmia, or in that still more rapidly destructive form of general inflammation leading on to suppuration, which sometimes follows surgical or accidental injury, and is sometimes produced by blood-poisoning. It suffers in all forms of glaucoma, whether primary or secondary. Its share in these various affections does but constitute a complication of them, and will be found described in the articles in which they hold the first place. The writer proposes here to confine his attention to those diseases of the choroid which, as far as can be ascertained, originate in the membrane itself.

The history of development proves the choroid to be essentially a dermal structure, and many of its diseases bear a marked analogy to those which affect the skin. They are of high importance to vision, but they owe this importance to the accident of locality. An inflammation of the choroid strikes at the root of the nutrition of the perceptive elements of the retina; and hence, when it occurs anywhere near the centre of the fundus, it is always attended by early and great disturbance of vision. Where the disease passes into atrophy, the perceptive elements of the retina participate in the change, and a permanent blind spot, of situation and magnitude corresponding to that of the atrophy, will be the result. In this respect, the inflammations of the choroid present a marked contrast to those of the retina. The latter are chiefly situated in the connective tissue of the fibre-layer, and hence, even when the morbid changes are very conspicuous, they may not affect vision at all.

INFLAMMATION.—The various forms of primary choroiditis have been distinguished by names more or less descriptive of the aspects which they usually present, so that choroiditis has been called disseminated, areolar, wandering, circumscribed, and the like. The differences thus noted are sometimes rather accidental than essential; and the points of chief importance, in any case, are to determine whether or not the disease is syphilitic, and whether it is confined to peripheral portions of the membrane, or is likely to extend to the neighbourhood of the yellow spot.

Disseminated choroiditis.—In the typical form the fundus of the eye is sprinkled over with spots, which may be compared to those of a cutaneous eruption. Each spot, in its origin, has been a sort of pimple, formed of an aggregation of cells in the choroidal tissue. The pimple becomes the seat of a localised inflammation, and ultimately shrinks, destroying in its shrinkage the adjacent tissues, so that its seat is marked by a sort of scar. This scar is surrounded by a line of pigment, and its central parts are white, the colour of the sclera showing through the thin layer of choroidal and retinal remains which the inflammatory process may have spared. The parts around each spot are not affected, and the spots themselves are usually most abundant near the equatorial region, and comparatively seldom approach the yellow spot. Practically, they are of little importance to vision, insomuch that the occurrence of the disease may have been unnoticed. In examining the eyes of children who are the subjects of inherited syphilis, it is frequently found that the more peripheral parts of the fundus are sprinkled over with small white dots, each encircled by a pigment line, and showing that disseminated choroiditis has occurred and has been recovered from. When the earlier stages of the process can be observed, each spot appears as a slightly yellowish point, surrounded by a narrow area of increased vascularity, and which, by very careful ophthalmoscopic inspection, may be distinctly seen to be an elevation. The yellowish centre gradually passes into the whiteness of atrophy, and the surrounding vascular area gradually passes into a line of pigmentation.

The *areolar choroiditis* of authors is a form of disease scarcely distinguishable, as far as its essential nature is concerned, from the foregoing; but, from the locality which it is more prone to attack, it is much more serious in its consequences. The process of inflammatory thickening in the choroid seems to be much of the same character, but the individual patches are larger, they are usually situated near to the macular region, on which they not infrequently encroach, and they are apt to coalesce with one another. Hence, even if the macula be spared, the ordinary result of areolar choroiditis is to obliterate a large and irregular portion of the visual field. The aspect presented by the fundus is that it is studded, around the optic disc and the macula, with oval or irregular patches, centrally white and bordered by pigment; the whiteness of the centres being often broken by a few remains of choroidal vessels. Besides these patches there will be small black spots, some of which are probably accidental aggregations of pigment, while others, according to some observers, are fresh patches in an incipient stage.

Wandering choroiditis.—In this form there are no sharply bordered spots, either of primary exudation or of secondary atrophy, but the choroidal surface is invaded, here and there, by irregularly shaped patches of effusion, comparable to the irregular patches of certain cutaneous eruptions. Over each of these patches there is a damping of the brightness of the tisssue, and this damping is succeeded, in time, by irregular pigmentation, and by changes which approach, but seldom quite amount to, absolute atrophy. It often happens that wandering choroiditis may exist for a long period without exciting attention, that it ultimately either actually invades the macular region, or approaches sufficiently near to it to produce disturbance of vision, and that, if then treated with sufficient energy, its progress may be wholly arrested, and central vision completely restored. In such cases, over the lateral areas, in which it had previously run its course, no improvement is usually to be expected.

Central choroiditis.—Besides the foregoing essentially chronic affections, we sometimes meet with choroiditis in a more acute form, and it is then apt to invade the region of the macula in the first instance. The disease appears to commence as a patch of effusion in the choroid, immediately beneath the macula. From the very first it produces distinct impairment of central vision, the point looked at appearing to be obscured as by a patch of fog; while, in consequence of the disturbance of the retinal elements by swelling underneath them, objects are distorted, and often appear to be smaller than natural. De Wecker has described this state as being almost invariably syphilitic, and as appearing between the ordinary secondary and tertiary periods, often many years after the primary infection. He attaches great importance, as a diagnostic sign of syphilis, to a very slight turbidity of the vitreous, situated chiefly in the layers nearest to the retina, and presenting an aspect as if the humour were beset with fine dust particles. This special form of turbidity usually obtains, at first, only in front of the macula, and is only to be observed by the very careful use of the ophthalmoscope. It is probably the physical cause of an appearance frequently described by patients—a sort of quivering or shimmering in the fog by which the objects of direct vision are obscured. Such cases are always of great gravity; and the appearance of a central visual cloud, in a patient known to have suffered from syphilis, is a matter which calls for prompt action on the part of the surgeon. Under the most favourable conditions, syphilitic central choroiditis is likely to be a serious and protracted affection; which, if neglected at the outset, will almost inevitably extend to the retina, and may involve both this structure and the choroid in one common ruin, with consequent total destruction of vision.

Treatment.—In the treatment of choroiditis, the chief matters to be taken into account are the degree of acuteness of the disease, the extent in which it seems to threaten the region of the macula with invasion, and the evidence for or against its being of a syphilitic character.

In a certain proportion of cases, in patients who apply on account of some superficial ocular trouble, or of some error of refraction, we may find the more peripheral parts of the fundus studded over with the scars of disseminated choroiditis. If the central vision is good, and if the ophthalmoscope discovers nothing but scars, no spots of apparently recent disease, we may consider that we are looking at the relics of a past storm, and may dismiss the scars from consideration as completely as we should dismiss the scars of small-pox.

In cases of areolar choroiditis, or in cases of wandering choroiditis in which vision has recently become affected, we shall probably find, besides more or less atrophic or degenerative change, places in which some active mischief is in progress. Here and there, the brightness of the choroidal colour will be somewhat damped by effusion, and a careful use of the ophthalmoscope will perhaps show that, in these places, the retina is somewhat raised by subjacent swelling. The bending of the retinal vessels, as they pass over the margin of a suspicious spot, will often afford evidence of its being on a higher level than the parts immediately around it. When such appearances are presented it is necessary to recognise the existence of grave peril to the sight, and to insist upon the necessity of submission to careful and even rigorous treatment.

Having, in the first place determined, whenever the determination is possible, the presence or absence of a syphilitic taint, the next care of the surgeon must be to investigate thoroughly the general conditions of the patient, with regard both to function and to diathesis. The urine should be examined, not in a perfunctory manner, but thoroughly; with reference to quantity and specific gravity, and to amount of urea, as well as with reference to albumen and sugar, to lithates or phosphates. The liver should be examined by palpation in the erect posture; and, in a large proportion of cases, there will be good reason for commencing the treatment by the administration of two or three doses of a mercurial alterative, followed by moderate, but sufficient, purgation. The ordinary regimen and habits of life should also be inquired into, and corrected if found to be ill-regulated.

When these preliminaries have received attention, and when no syphilitic taint is discoverable, the medicine which the writer has found most efficacious is the mercurial perchloride, given to an adult in doses of the sixteenth of a grain three times a day, and usually combined with a small quantity, say three to five minims, of the tincture of perchloride of iron. Many practitioners direct such a combination to be taken immediately after food; but it will sometimes be found that this course is followed by dyspepsia, as if the iron interfered with the secretion of the gastric juice. Sir Henry Thompson has pointed out that, when this happens, the iron will often be perfectly well borne if its administration is deferred until three hours have elapsed after a meal.

An important adjunct to treatment will often be the abstraction of blood from the temple by Heurteloup's or some other artificial leech. The process is, in fact, a form of cupping, and it is more advantageous than the use of the natural leech, which abstracts the blood more slowly, and after prolonged suction which produces a congested state of all the neighbouring parts. About two fluid-ounces of blood should be taken quickly, and the bleeding may be repeated from time to time, according to the local and general conditions of the patient. It is desirable entirely to screen the eye from light for some hours after the bleeding; and, for this purpose the little operation is best performed at nightfall. The patient should remain in bed during the whole of the next day, in a completely darkened room, and should not be exposed to light until the morning of the third day.

Even then, the exposure should be careful and gradual; and, especially in the spring and summer seasons, dark spectacles should be worn in full daylight. All functional use of the eyes, even if one of them is quite sound, should be strictly forbidden, and a reader and amanuensis must be employed if there should be any business which imperatively requires attention.

The absorption of effused materials may often be much promoted by the use of pilocarpine diaphoresis, which serves to empty the blood-vessels without exhausting the patient. The best preparation for the purpose is the pilocarpine hydrochlorate, in the form of a ten per cent. solution in distilled water. For an adult, two minims of this solution may be injected hypodermically as a commencing dose, and it will generally be found that three or four minims may be given on subsequent occasions. The patient should go to bed, with warm coverings, and the dose should be given about an hour after breakfast. The place of injection is immaterial, although the first signs of perspiration will appear in the immediate neighbourhood of the puncture. In some people, the diaphoresis will be attended by free salivation. The whole effect terminates in about three hours, after which time the patient may rise, be rubbed dry, and return to his or her usual avocations.

By the adoption of such a course as this, the progress of the disease will often be arrested, and the central vision, if it were only beginning to suffer, will be restored. Even when good results are speedily obtained, it is desirable to continue the mercurial perchloride for several weeks, and at all events as long as any appearance of effusion or recent mischief is visible with the ophthalmoscope; and only to permit a very slow and careful return to the functional use of the affected organ or organs.

In the more acute cases of disturbance of central vision, with the appearance of a quivering cloud over the fixing point and with distortion of objects, the surgeon has to deal with an acute and highly perilous syphilitic affection. De Wecker advises that recourse should be had to rapid mercurialisation, preferably by inunction; but the writer is strongly of opinion that mercury, as a means of arresting the present symptom in the late forms of syphilis, whatever that present symptom may be, is decidedly less trustworthy than iodide of potassium, given energetically in the largest doses which can be borne. He would begin with ten grains three times a day, and would increase or diminish this quantity according to its effects. If symptoms of iodism should occur, the dose should be diminished to any necessary extent. If there were prompt improvement, and if this, after the lapse of a short time, seemed to be no longer continued, the dose should be increased again and again, if the described conditions should recur. The facts which point to the great value of the iodide in arresting a syphilitic symptom at a late period of the disease, point also to its remarkable inefficacy as against the syphilitic taint—a taint which can only be eradicated, when it can be eradicated at all, by the persistent use of mercury. In such a case as that now under consideration, the object of the writer would be, first to save the eye from destruction by the iodide of potassium, and then to cure the patient of his syphilis by mercury, which, for this purpose, should be continued for something like a twelvemonth. In any instance in which the administration of the iodide was not followed by speedy improvement, that is to say, by improvement within the first four or five days, it would be most judicious to lay it aside, and to proceed at once to mercurial treatment, not in the manner advised for the milder forms of choroiditis, but so as to produce a trace of effect upon the gums as speedily as possible. For this purpose, the surgeon would have his choice between inunction, fumigation, and administration by the mouth, and would be much guided by the general state and surroundings of the patient.

In many instances, the slight turbidity of the vitreous body, which has been already noticed, is prone to pass into turbidity of a coarser kind, composed of flocculent masses of exudation-material; and these, by their ready mobility within the eye, show that the vitreous itself has undergone fluid degeneration. Such a condition affords ground for a very unfavourable prognosis, since absorption of effused products within the vitreous is accomplished with extreme slowness, even if at all; and their formation indicates the existence of a very serious amount of morbid change. It sometimes occurs, however, that the affection of the choroid will subside under treatment and that the function of the retina may be preserved, while the flocculi remain almost unaltered, and produce obscuration of objects only when they chance to intervene between the point looked at and the yellow spot. In the worst cases, the extension of the disease is not confined to the vitreous body, but passes forwards to the iris and to the cornea, leading to the deposit of numerous dots of inflammatory deposit upon the posterior surface of the latter membrane, as well as to general turbidity of its structure. When such complications occur, they leave but little hope of a favourable issue. *See Keratitis punctata*, under Cornea, Inflammation of the.

In some instances the effusions which are occasioned by choroiditis produce detachment of the retina, and in others they are poured out between the choroid and the sclera, and detach both the internal membranes together. The ophthalmoscopic appearances are much the same in both cases, save that, when the retina is detached alone, it possesses a certain degree of mobility, and floats up and down within the eye something in the manner of the sheet by which waves are imitated upon the stage. When the retina and choroid are detached together, the greater thickness and firmness of the combined structures prevents the occurrence of these floating movements, and furnishes a symptom by which the nature of the elevation may be determined. The only available treatment is to puncture the sclerotic in the region of the detachment, so as to allow the sub-choroidal fluid to escape, and to permit the detached structures to return to their natural position. In some instances this procedure has certainly been beneficial, and reunion to some extent appears to have occurred. In order to make the puncture the eye should be brought under the influence of cocaine, and then, the place of detachment having been exactly ascertained, the conjunctiva should be drawn aside, and a cutting-needle thrust into the eyeball somewhat obliquely, and turned slightly on its axis as soon as the escape of fluid shows that sufficient penetration has been effected. When the fluid has all escaped the needle is withdrawn, and the conjunctiva is suffered to return to its proper position, so as to cover the scleral puncture. No dressing will usually be required beyond a slight pad to maintain closure of the lids during the healing process. The writer's own experience of the effects of this procedure is less favourable than the accounts which have been given of it by others; but it is at least tolerably certain to do no harm.

In cases which terminate unfavourably, and in which choroiditis leads on to complete loss of vision, followed by wasting or shrinkage of the eyeball, the shrunken organ is sometimes a source of danger to its fellow. The material effused into the degenerated choroid sometimes becomes the seat of calcareous deposits, and sometimes undergoes conversion into true bone. In either of these conditions the eye is apt to become painful and tender, and there have been several instances in which it has excited sympathetic ophthalmia. It is therefore always desirable, when an atrophied eye is tender to the touch, and especially when it can be felt to contain hard deposits, to anticipate danger by enucleation.

Suppurative choroiditis.—A brief reference has already been made to the acute form of choroiditis which leads rapidly on to suppuration, and which, in the majority of instances, is either traumatic or septicæmic. In the 'acute panophthalmitis' which sometimes follows the extraction of cataract, the choroid is only secondarily affected by extension from the parts actually implicated in the operation; but in cases of septicæmia, puerperal or other, we frequently see almost complete loss of vision, while the iris and cornea as yet participate but slightly in the morbid action. This, in such instances, probably commences in the venous plexus of the choroid. Not only the iris, but all the other structures contained within the eyeball, speedily become involved in the inflammation, which can scarcely be said to admit of treatment, and which occurs as an accidental complication of a severe and dangerous constitutional malady. The distension of the eyeball is apt, however, to be extremely painful, and the pain thus arising may be relieved, generally speaking, by incising the sclerotic with sufficient freedom to give exit to pus and other morbid products. The expediency of making the necessary incision would depend greatly upon the general state of the patient, but the best situation for it would usually be between the external and inferior recti muscles, on a line extending from the ciliary region almost to the entrance of the optic nerve.

Hæmorrhages.—The choroid is sometimes the seat of hæmorrhages, the pathology of which is obscure, but which occur chiefly in aged people, and probably, like some retinal hæmorrhages, point to the existence of general arterial degeneration. The blood may be effused either between the retina and the choroid, or into the choroidal stroma, or between the choroid and the sclera, or to some extent in all these situations; and the ophthalmoscopic appearances will be governed partly by the precise situation of the blood and partly by its quantity. Choroidal hæmorrhage is attended by sudden loss or great impairment of vision; and the ophthalmoscope discovers a dark patch, generally with sharply-defined borders, over which the retina is visible as a slightly opalescent film, and with the continuity of its vessels unbroken. As by an inflammatory effusion, the retina may be detached from the choroid, or the chroiod and retina together may be detached from the sclera; but, even in the former case, the detached retina is but slightly tremulous, being usually supported by the blood beneath. After a short time the original appearances may be greatly masked by atrophic or other secondary changes, and by the gradual decolorisation of the clot.

The *treatment* of choroidal hæmorrhage must be conducted on general principles. The first indication will be to diminish the probability of further bleeding, the next to procure the absorption of the blood which has actually been poured out. Complete functional rest of the eyes, complete quiescence of the body, gentle purgation, and great moderation in the quantity of fluid swallowed, will afford the chief means of fulfilling the first indication; while the second will call for the careful administration of iodide and bromide of potassium, of perchloride of mercury, or of other remedies suggested by the general condition of the patient.

Choroidal hyperæmia has been described by some authors. It would be difficult to deny that a vascular structure may sometimes contain an excessive quantity of blood; but it would be impossible to draw any line between physiological and pathological vascularity, or to assign any symptom by which the alleged hyperæmia could be recognised with certainty.

Cysts and Tumours.—The choroid is liable to cysts and tumours of various kinds, the most important of which are sarcomatous or melanotic growths. The first indication of a tumour of the choroid is usually given by its lifting up the retina, and thus producing some disturbance of its contour. The result of such disturbance is that the part of the visual image which falls on the elevated portion of the retina will appear to be distorted. If the tumour be approximately central, near the yellow spot, the distortion thus produced will speedily force itself upon the attention even of the most unobservant; but, if the tumour be peripheral, the distortion, although obvious if looked for, may long remain unnoticed by the patient. Whenever it is complained of, a slight elevation of the corresponding portion of the retina will usually be discoverable by the ophthalmoscope, and it is possible that the colour of the subjacent portion of the choroid may be changed; as, for example, that a melanotic growth might reveal its probable nature, even at this early period, by the dark tint of the affected region. The diagnosis between a morbid growth and a detachment of the choroid will seldom present difficulty, since the latter is, as a rule, attended by diminished tension, while the growth, for obvious reasons, is almost of necessity attended by increased tension. If it increase in bulk, this increase of tension soon becomes more evident, and is, of course, accompanied by pain, as well as by other consequences of irritation which soon tend to conceal the details of the case. When a tumour commences at some point between the equator and the ciliary body, it may be visible through the pupil, either by focal illumination or by the ophthalmoscope, and it may attain some magnitude before vision is destroyed; but, in a general way, complete detachment of the retina is an early consequence of any choroidal growth. At the same time, the cornea is apt to become cloudy, and the transparency of the humours to be diminished by the presence of effusion; so that, except in quite an early stage, it will scarcely be possible to do more than determine, from the history of the symptoms and from the distension of the eyeball, that some form of morbid growth is inclosed within. If no treatment be employed, the further progress of the growth may either be to distend the eyeball as a whole, or to produce thinning and prominence of the sclera in some one direction. *See* ORBIT, Tumours of the.

Treatment.—The presence of a morbid growth in the choroid calls imperatively for enucleation of the eye, as soon as the diagnosis can be arrived at with certainty. The melanotic and sarcomatous tumours are prone not only to recurrence, but also to recurrence in other regions; and the best prospect of avoiding recurrence is afforded by early removal. Even cysts, and other harmless tumours, are certain causes of great pain and of loss of sight; and it is, generally speaking, impossible to arrive at certainty about the nature of a growth as long as it remains within the eye. When there is unquestionable malignancy, removal may not only afford much present relief from suffering, but may also delay, possibly for many years, the ultimate fatal issue.

If the enucleation of an eye which contains a malignant tumour of the choroid be too long delayed, the disease may have crept along the optic nerve, in which case it is manifest that speedy recurrence must be looked for. In performing enucleation for such a tumour, whether choroidal or retinal, it is always desirable to divide the nerve at the apex of the orbit instead of immediately behind the eyeball, and this may be done without difficulty by the employment of scissors with blades somewhat longer than those commonly used. Some surgeons have advised that, after the ordinary close section, the cut surface of the nerve should be examined, and that, if it shows any signs of the extension of any morbid process, the stump should be felt for with the finger, seized with strong toothed forceps, drawn forward, and cut off as far back as possible. It is better to anticipate such a proceeding by a deep section in the first instance, since the complete removal of the trunk of the optic nerve does not appear to diminish the fitness of the ultimate stump for carrying an artificial eye.

Coloboma. — Occasionally coloboma of the iris extends to the choroid. The deficiency in such cases is always downwards, and is sometimes continuous with that of the iris, sometimes separated from it by the intervention of an unbroken ring of ciliary body. The coloboma of the choroid is very variable in its width, and may either surround the circle of the optic nerve, or may stop short of its lower margin. The gap is seen with the ophthalmoscope as a white patch, of a generally oval outline, traversed by more or less wasted remains of the retina, some vessels of which are always distinguishable. Beneath the coloboma, the sclera is usually somewhat bulged out or staphylomatous; and the portion of retina which crosses it is usually insensitive, so that the deficiency is marked by a blind spot of corresponding position and magnitude. The precise appearances differ much in different cases; and no treatment is available in any of them.

R. Brudenell Carter.

CHOROID, Injuries of the. — The choroid is liable to participate in many forms of injury to the eyeball, which will be noticed in the proper place, and in which its participation is likely to give rise to a larger amount of intraocular hæmorrhage than would otherwise occur. It is also liable to be ruptured by direct violence, without injury to the other tunics; as in cases in which the eye is struck by the rebound of a twig or by a tennis-ball. The rupture, in such circumstances, is always by *contre-coup*, and usually occurs near the entrance of the optic nerve. It is attended by hæmorrhage, by which, for a time, vision may be entirely obscured; but, in most instances, improvement of sight is to be expected when the blood is absorbed. As soon as an ophthalmoscope can be employed, the seat of the injury may usually be seen, as a linear or crescentic line or lines, more or less buried under coagula; and, as the coagula disappear, the whiteness of the sclera may be seen through the gap. If the injury encroaches upon the region of the yellow spot, central vision is likely to be practically destroyed; and, in other cases, in which it is at first but little affected, there is always some risk of subsequent impairment, due to changes in the nutrition of the retina, or to the contraction of scar-tissue.

Treatment.—When injury to the choroid is suspected, the only treatment called for is the use of atropine, of sedative lotions and fomentations, and complete rest of the sound eye, until the time comes at which the diagnosis can be made certain by the aid of the ophthalmoscope. Inflammatory complications, if they should arise, must be dealt with in the usual way; and no use of either eye should be permitted until the absorption of the effused blood is complete.

R. Brudenell Carter.

CHRONIC RHEUMATIC ARTHRITIS.— An essentially chronic form of joint-disease, occurring in persons of rheumatic predisposition, affecting both small and large, one or many, articulations. It may begin insidiously with gradually increasing pain and swelling, or with more acute local symptoms. All the tissues of the joint are implicated by a chronic, and often progressive, inflammatory process, which appears to arise in the cartilages, and engages successively the synovial, bony, and ligamentous structures. Both sexes are affected, but females in larger proportion, and the disease may begin at any period, from early childhood onwards.

Cause.—Any conditions which determine the onset of symptoms commonly recognised as rheumatic, may lead to this disease. To state that all persons are not predisposed to rheumatism, is to affirm the existence in some of a habit of body peculiarly susceptible to the influences which excite it; and that such predisposition in the nature of diathetic proclivity is found in many individuals, is now believed by some of the best authorities, and the writer holds this opinion very strongly.

We have now to study the effects of certain influences upon those diathetically predisposed to rheumatic disease in general.

Foremost amongst these must be considered heredity. This counts for more than was formerly believed. Recent careful inquiries on this point furnish in most cases a clear history of rheumatic ailments in the ancestry. All circumstances provocative of catarrh must be reckoned as potent existing causes. Hence, residence in low-lying localities, on sodden soils, in ill-built or new houses, or on the ground floor, is frequently a cause. The disorder more certainly ensues upon exposure to moist conditions than to mere cold. Cold and dry climates appear little causative. It is unknown in the polar and in the equatorial regions.

Next must be mentioned all causes leading to exhaustion and enfeeblement of the nervous system, including especially an imperfect and innutrient dietary, overwork of body and mind, prolonged grief and anxiety. In women the frequency of onset after numerous pregnancies, hyperlactation, and menorrhagia is especially to be noted. Occupations such as those of laundry-women, bakers, and stokers specially affect those persons who are predisposed, the conditions obtaining in these cases being exposure to damp heat, and rapid alternations of temperature, together with vigorous bodily labour. Gardeners and out-door labourers are likewise exposed by their occupations to heavy muscular work and to wet, the former also to alternations of temperature when working under glass. The influence of moisture, apart from low temperature, is noteworthy in the cases of the very rheumatic peasantry in Ireland and the West Coast of Scotland, where, in addition to constant dampness of climate, habitation, and clothing, the dietetic conditions being also unsatisfactory, no severe cold is experienced. The influence of exposure to night air and of chill after fatigue is very marked.

Traumatism, undoubtedly, has much to do with the onset of rheumatic arthritis. Local injuries, seemingly trifling, also boils and whitlows, may set up the disease, which may thereafter spread to other articulations. Over-use of joints may also determine the onset of it. Rheumatic predisposition thus carries with it a special vulnerability. It has been taught that symmetrical invasion of joints alone indicates constitutional taint in this disease, but the writer believes that the local manifestations of the disorder are often equally significant of this.

The influence of diet has no etiological bearing on rheumatic arthritis, save only in respect of insufficiency and imperfection.

Amongst less well-recognised causes are chronic dysentery, and arterio-capillary fibrosis with contracted kidney.

Pathology.—The exact nosological position of this malady is not yet fully determined. Space forbids a review of all the opinions held at the present time. Those which commend themselves to the writer may be briefly expressed under two heads: (1) That this disease is a form of true rheumatism; and (2) That many of its characters seems to be dependent on lesion of the spinal cord, occurring thus specifically, or otherwise excited secondarily by peripheral irritation.

These views may be best considered together. The disease is one of several manifestations of the rheumatic branch of the basic arthritic diathesis. Gout is regarded as another branch of the parent stock. This position necessarily entails an indirect relation with all forms of diathetic arthritic disease, and, hence, the occurrence of chronic rheumatic arthritis is not antagonistic to the onset of other phases both of rheumatism and gout. The disease may therefore occur *specifically* in more or less grave form. Careful study of its etiology further indicates that in many cases the disorder is *symptomatic*, is 'a lesion common to several kinds of ailment' (Ord), capable of provocation by varied sources of peripheral irritation, amongst which may be enumerated injuries, over-use of joints, and, in particular, irritative conditions of the genitalia, as gonorrhœa, urethritis, ovario-uterine troubles, &c. Symptomatic arthritis, then, is regarded as a product of spinal tropho-neurosis. The nervous system is markedly implicated in the arthritic diathesis, and many of the features both of rheumatic and gouty disease point to the probability of there being a trophic centre, or centres, for the joints situated in the spinal marrow. Morbid or unstable conditions of these centres may result in a definite neurosis, which itself may be either inherited, acquired, or modified in particular instances.

The term 'rheumatic gout,' so often used as a synonym for this disease, the writer believes to be quite inapplicable save for a minority of cases where a true coalescence occurs. Gouty manifestations may supervene independently in the subjects of rheumatic arthritis, or may blend with rheumatic conditions; and in the course of many generations transitional modifications may occur and give rise to unusual forms of arthritis whose place is not always readily determinable. It is also probable that some of the irregular forms met with may be due to coalescence with other inherited diathetic states. Although there is an indirect relationship between rheumatism and gout, the two diseases are remarkably distinct from each other and from rheumatic arthritis.

It is further to be noted that coincidences of structural change after death do not imply identity of morbid states leading up to them. Thus, it has been shown that chronic gout may produce some of the changes in joints which were formerly attributed exclusively to rheumatic influence. It has been alleged that the rheumatic diathesis is universal. The writer denies this. Some individuals will never develop rheumatism in any form, however much exposed to exciting causes. Arthritic changes, not readily distinguishable from rheumatic disease, are met with in other mammals, and are also proved to have been existent in prehistoric periods.

The forms assumed in this disease are best described under the heads of acute, chronic, and irregular. The acute and general form is more common in young persons, is met with even in childhood, and especially in women, and then assumes the characters of a severe constitutional disease in more marked form. At the menopause, too, it is apt to be acute and rapidly progressive. The smaller joints, especially of the hands, suffer more in this form. The chronic variety is of more insidious origin, is met with more often after middle life and in the male sex, affecting more particularly larger, and often single joints. Many exceptional cases are, however, met with. In by far the majority of cases, no associated visceral lesions are found, and, in exceptional cases, these may be commonly traced to antecedent attacks of rheumatic fever. No indications of important changes have been hitherto discovered in the blood or in any of the secretions in this disease, although some degree of anæmia is not infrequent in advanced cases.

The morbid anatomy of this disease relates to changes in the synovial membrane, cartilages, bones, tendons, and ligaments composing the affected joints. The appearances vary extremely, according to the stage and duration of the disorder, and differ, too, in the several joints affected. Hydrarthrosis sometimes occurs in the early stages, due to effusion into the synovial sac. This may lead to much distension of the capsule, to undue mobility, to subluxation and even complete dislocation. Recovery from this relaxed condition is naturally slow and often imperfect. *Hydrops articuli* is most common in the knee, shoulder, and elbow. Stretching of the lateral ligaments occurs in the ginglymoid joints as a consequence. The fluid removed does not present extraordinary characters, clear or fatty epithelial cells being found as in normal synovia. The synovial membrane is red and thickened, with hypertrophied vascular tufts. At a later stage the fluid is absorbed, leaving the synovial membranes unduly thick, and the capsular ligaments altered to the consistence of intervertebral cartilage, and even at times bony in structure. *See* CHARCOT'S DISEASE.

The articular cartilages present marked changes. They early lose their brilliancy, and become of a dull, yellow colour. They soften and waste, becoming thin, villous, or fibrous in texture. In the knee the semilunar cartilages may entirely disappear, or, contrariwise, become much hypertrophied and even bony. In the phalangeal joints the centre of the articular cartilage becomes villous, eroded, and wasted, exposing the bone. The first stage consists in hypertrophy, with increase in the number of the cartilage-cells and formation of capsules around them. The primary capsules on the surface become globular and distended, and ultimately burst, discharging the free cells into the joint. The next layers of capsules tend to run into a linear series perpendicular to the surface, forming parallel rows of tubes filled with cells, exactly as met with in an ordinary process of intra-cartilaginous ossification. The proliferation of these cells results in formation of embryonic medullary tissue. The grooves which lodged the cells become filled with synovia or cellular débris. The matrix of the cartilage becomes linear, fibrous, and villous at the free end of the tissue. In some of these villi may be found swollen capsules, giving a club-shape to their extremities. Owing to friction in progress of the disease, the villi disappear, and the bone is exposed and in turn undergoes specific changes. Small nodules are formed at the edges of the cartilaginous investment--true ecchondroses, giving rise to the well-recognised nodosities of Haygarth and Heberden (nodular rheumatism). Later on these ossify.

At this time, in the case of the larger joints, the synovial fringes and ligaments are undergoing changes, dendritic growths occur, accompanied by newly-formed bloodvessels. These buds or growths likewise become cartilaginous, and sometimes pedunculated, tending to break off and form loose bodies in the joint. Cartilage corpuscles are sometimes normally found in synovial fringes. They may become truly bony. Ecchondroses, presenting these characters, are not significant only of chronic rheumatic arthritis, since they may be found in both strumous and gouty arthritis. They are necessitated by the anatomical features of the joint, and hence are common in arthritis of any kind, provided the process is sufficiently grave to induce them. The proliferating elements tend to accumulate at the edges of the joint, because these parts are invested by synovial membrane which includes them, and prevents their being shed into the cavity of the joint. Thus, cartilaginous overgrowths occur at any point covered by fibrous tissue or synovial membrane, and especially at the insertions of tendons and ligaments.

The bony changes are of two kinds, proliferating and atrophic, and both proceed together in different places. The former are seen in the ossification of ecchondroses, which begins at their bases. The newly-formed osteophytes undergo friction and eburnation on their surfaces. They resemble epiphysial exostoses in their structure, and are best seen in cases of *malum coxæ senile*, the head of the femur becoming expanded, and the neck of the bone curtailed. Around the acetabulum these bodies are abundantly thrown out, so that the size of the cavity is enlarged *pari passu* with its occupant. The knee-joint sometimes presents profound deformity from similar changes.

The atrophic changes are seen on the articular surface after the removal of the cartilage, and are related to the process of eburnation. The proliferating cells of the cartilage next the bone are believed to press on this texture and induce absorption of it, thus shedding themselves into the adjacent medullary spaces, and leading to conversion into, and incorporation with, new bone-corpuscles. In one or other of these ways a layer of dense bone is formed, which protects the delicate cancellous structure. Eburnation may also arise directly from inflammatory change in the cancellous tissue. On the eburnated surface may be found worn or wasted patches exposing spongy bone, and in most cases lines and grooves exist in the direction of motion, due to continued friction.

With all these profound changes it is remarkable that ankylosis is of extreme rarity. There may be complete immobility. This, however, is due not to fusion of the component structures, but to mechanical impediments, both in and around the joint. Destruction of the internal ligaments of an affected joint is common. The crucial ligaments in the knee may be disorganised, detached, or removed by absorption. The round ligament of the femur, and the tendon of the long head of the biceps within the shoulder-joint, may likewise be ruptured or removed. Bursal tumours also occur in the vicinity of affected joints.

The condition of the spinal cord, and of the nerves supplying affected joints, has not yet been studied. Researches in this direction are desirable. The heart and pericardium commonly escape associated inflammatory changes, but not always.

Symptoms and Diagnosis.—The early symptoms consist of pain, heat, stiffness, and swelling in the affected joints, with, sometimes, spasmodic startings of muscles. The pain is especially felt at night when the patient is warm in bed, or on awaking, also on resuming movements after repose. Grating and crackling sensation in the joints is both subjective and objective. The pain is of a burning or boring character, and may often be relieved by stretching and movement. In some cases no pain accompanies the progress of the disorder.

Deformities of varying extent now ensue, leading to knobby or knotty fingers, and more gross outlines in the larger joints. Temporary arrest of symptoms may occur, with recurrence under fresh provocation. A single joint may be affected, as in the case of the hip, leading often to diagnosis of sciatica or intracapsular fracture in elderly people. Patients are sensitive to climatic changes, and suffer from cold and damp, also, as the writer has found, in advanced cases, from extreme heat. As the disorder progresses, more and more crippling ensues, till the joint-movements become practically annulled by mechanical impediments. Spurious ankylosis is set up. Suppurative change is practically unknown. If many joints are severely involved, the patient becomes a complete invalid or bedridden, and frail health, with anæmia and languor (arthritic cachexia), is thenceforth established.

In the general form of the disease the joints are centripetally affected, and the upper limbs are commonly first attacked with more or less symmetry. The metacarpo-phalangeal joints of the thumb, fore and middle fingers are especially and early obnoxious, and the wrist, carpal, metacarpal, and phalangeal joints generally are the most frequently attacked.

Changes in the axis of the fingers arise, leading to eversion of them towards the ulnar side of the arm, and in young subjects varieties of flexion and extension of the several segments of the hand occur, as the result of spasmodic muscular contractions, which may also lead to subluxations. Axial distortions are by no means pathognomonic of this affection, being found occasionally in chronic gout. They are due to the influence of the extensor muscles of the wrist and fingers, the movements of abduction being more powerful than those of adduction. With late onset of the malady these latter deformities less frequently appear, doubtless because the muscular irritability is less, the parts more rigid, and the process less acute or less general. Slow wasting of muscles is common in the neighbourhood of the affected joints as a result of disuse. Rapid wasting occurs in acute forms of arthritis, and is probably of reflex nervous origin—a true neurotrophic lesion.

Spondylitis is happily not common, but must not be forgotten. The cervical and lumbar vertebræ suffer more than the dorsal, and the atlo-axial joints most of all, perhaps because motion is there more free. The temporo-maxillary joints are sometimes affected, and occasionally unilaterally, leading to remarkable deformity. Eburnation may occur here. The lower limbs often suffer symmetrically, motion being restricted at the hips, while the thigh is bent on the pelvis, and the leg on the thigh. The femur projects on the tibia, the external condyle being prominent, and the patella, usually enlarged, resting upon it. The head of the fibula may project. At the knee there may be spurious ankylosis; at the tibio-tarsal joint more complete interlocking, the foot being either adducted or abducted, simulating respectively pes valgus or equino-varus. The great toe is commonly everted, and may overlap the others.

The diagnosis in the general form of the disease may be difficult in an early stage, where many joints have been acutely affected and rheumatic fever has been suspected. Many cases begin as ordinary acute rheumatism, and, not yielding to treatment, linger on with progressive deformity and pain. The diagnosis may thus be impossible at the outset, It must also be made from the polyarthritic form of gout, with which it is sometimes confounded when no uratic deposits are obvious. The latter must be sought especially in the cartilages. Evidence in favour of gout will be found by inquiry into habits as to diet, and as to heredity, by examination of the urine and of the blood for uric acid. Associated lead-taint will declare for gout. A history of previous articular attacks in a great toe, or knee, followed by desquamation of cuticle; of inability to take malt liquors, or certain articles of food, without bringing on, sometimes promptly, joint-pains, points to gout.

Treatment.—More agreement prevails on this point than on the question of nosology. In brief, it may be affirmed that what is good for rheumatic manifestations anywhere is good for chronic rheumatic arthritis. The principles of treatment must vary somewhat with the exciting and determining causes in each case. Attention must be paid to the existence of any cross-taint. Little good will be gained till a better condition of general nutrition, and of the nervous health, is secured. All causes of depression and exhaustion must be removed. A good and varied dietary is essential, including free use of foods containing sulphur, such as onions, cruciferous vegetables, and especially mustard. Fats are of value, and cod-liver oil ranks high as a remedial agent. Animal food is conspicuously absent from the diet of the worst sufferers in Ireland and the western islands, and potatoes constitute the main vegetable support, with a scant allowance of milk. Fish is desirable, especially when fresh. A moderate allowance of malt liquor or of good wine with one meal daily, is generally advisable. Residence should be sought in a sheltered, dry, and somewhat elevated locality. It is probable that the disease would often be arrested if tropical, or semi-tropical, residence were secured for a few winters in an early stage. High value attaches to early treatment. Rest is necessary when there is much local pain, and splints and cotton wool may be required. Belladonna, opium, camphor, or soap liniments are the best applications in the acute stage. Where there is much effusion, thecal or other, iodine or cantharidine liniment may be applied, care being taken never to encircle any joint completely. Acute pain that will not at once yield to anodyne applications may be relieved by leeching or wet-cupping.

The medicinal treatment of the acute stages consists of salicylate of soda in twenty-grain doses every six hours, or of iodide of potassium and quinine given together in the respective proportions of five grains and one or two grains, made soluble with one or two minims of dilute sulphuric acid. Quinine with citrate of potash is also of value. Small doses of compound soap pill may be given by day to secure repose, or ten grains of Dover's powder each night, if necessary.

In chronic conditions the following drugs are found most useful. Cod-liver oil, iodide of potassium pushed to ten or fifteen grains for a dose, arsenic in full doses, iron, and sulphur. Lemon juice has been of proved service in some cases. Guaiacum, sulphur, and acid tartrate of potass, in the form of the 'Chelsea Pensioner' electuary has been found of value as a local application. Flannel soaked in cod-liver oil is a good remedy for the aged poor in cases of languid circulation with dry skin. Exercise is of much importance to secure the best relations between the altered articulating surfaces, to anticipate spurious ankylosis, and so preserve the functions of the limbs. Skilful treatment by shampooing and massage, and by electricity, has a prominent place, and the resources of the best British and foreign warm sulphurous and saline spas are of high value. In this country the waters of Bath, Buxton, Harrogate, Strathpeffer, Woodhall, and Llandrindod are in the highest repute; while on the Continent those of Aix-la-Chapelle, Aix-les-Bains, Baréges, Bourboule, Franzensbad, Gastein, Kreuznach, Pyrmont, Teplitz, Wiesbaden, and Wildbad, are well adapted for resort. The arrangements at Aix-les-Bains are admirably adapted for successful treatment. Several seasons in succession should be spent at one or more of these spas in order to secure full benefit. Hot sulphur douching is of proved utility. Peat-baths and hot sand applied locally are available remedies at some of the foreign spas. The pains and weariness of the later stages of the disease are best met by opium in small doses, and by bromide of potassium.

Well-adapted support to joints by soap plaster spread on thick buckskin is very useful for the knees, and daily use of the flesh-brush is advisable. Woollen under-clothing must be worn all the year through. Elderly patients should get daily exercise in the sun, whenever possible, and all exposure to draughts and damp must be carefully avoided. The malady is practically incurable in the old, and early treatment of all cases is imperative if arrest of it is sought. The importance of following up each case of acute rheumatism, till perfect health is restored, is obvious.

Dyce Duckworth.

CHYLURIA. — *Synonyms*: Chylous Urine; Hæmato-chyluria.

Definition.—A milky appearance of the urine, due to the presence of suspended fatty matter having the characters of chyle, and generally occurring in persons infested by a nematoid worm, the *filaria sanguinis hominis.*

Cause.—Chyluria is essentially a disease of tropical and sub-tropical climates, but occasionally it occurs in persons who have never left temperate regions, where the disease does not prevail endemically. Whilst the immediate cause is probably the same in these two classes of cases, the remote cause most likely differs, as will be made more apparent under the head of Pathology. Though the disease does occur occasionally in those who have never resided in the tropics, most of the cases observed and recorded in this country have been imported from regions where the disease is endemic. Chyluria occurs in both sexes, perhaps slightly more frequently among females, and at all ages. The remote cause of the endemic cases is the infection of the patient with the *filaria sanguinis hominis.* Violent exercise or exertion sometimes determines the outbreak of the disease.

Geographical Distribution.—The disease is endemic in the Mauritius, Isle of Bourbon, West Indies, the Brazils, Egypt, India, China, and Australia; the range probably, as stated by Lewis, being limited by about 30° south, and 30° north latitude.

Pathology. — The analyses of many eminent chemists show that all the elements of chyle are present in the urine. Though the proportion of the main constituents of chyle — fatty and albuminoid — differ in many cases from the proportion in which they occur in chyle, this discrepancy is of doubtful significance, since the examinations of both chyle and urine have not been studied, with sufficiently exact reference to the ingestion and quality of food, to admit of accurate comparison. Vandyke Carter has shown that the correspondence may be close.

In order to understand how chyluria may be brought about, it is necessary to glance briefly at chylous exudations generally. In the first place, there have been recorded cases of chylous ascites, in which ascitic collections have had a milky appearance, suggesting, both from their appearance and chemical qualities, an admixture of chyle with serous effusion. These have been proved in some instances to be due to tumours pressing on the thoracic duct or lacteals (Hughes, Ormerod, Wilks.) In consequence of such pressure the lacteals have become distended, dilated, and varicose, and rupture or leakage has followed, so that chyle has become commingled with the dropsical effusion due to pressure on the trunk or branches of the portal vein. These cases are very important, as supplying anatomical proof that the milky appearance of the exudation was caused by admixture of chyle with the serous fluid. Winkel has recorded a case of chylous ascites in a woman who came from Surinam, and in which he thought he detected filaria in the fluid. His description, however, leaves this point doubtful. Quineke has recorded a case of milky effusion into one pleural cavity, probably due to rupture of the thoracic duct by injury. Milky fluid was also found in this case in the peritoneal cavity, and was ascribed to anastomosis between the pleural and peritoneal lymphatics.

Cases have been recorded in this country of encysted hydroceles in which the fluid has been milky. Such cases appear not to be uncommon in the regions in which chyluria prevails. They have been shown to be associated with the presence of filaria in the milky fluid and in the blood, and are attributed to rupture of congested lymphatics into the tunica vaginalis. Next there occur a series of cases in which milky fluid escapes from fistulæ, or eruptions in some part of the surface of the body. In the majority of such cases lymphatic obstruction can be easily demonstrated, enlarged and hardened glands, or varicose lymphatic trunks, being apparent. In these cases fluid escapes, often in very large quantities, from the affected parts, spontaneously, or as the result of accidental or intentional injury. The fluid has, in some cases, the qualities of lymph, containing albumin, fibrin, and lymph-corpuscles. But in many cases, at some period of their progress, and in other cases at all times, the fluid has a milky appearance, and chemical examination has shown it to contain all the constituents of chyle. Such local discharges of lymphous or chylous fluid are generally situated on the trunk or at the proximal extremities of the limbs, parts at which regurgitation from obstructed and dilated lacteals would be relatively easy. Cases of this kind, known as 'lymph-scrotum,' 'varix lymphaticus,' or 'nævoid elephantiasis,' are very common in countries where chyluria prevails, occasionally co-exist with chyluria, and have been shown to be connected with filarial infection, either local or general. At the same time cases have been recorded in persons who have never left this country (Buchanan, Roberts, &c.), so that it is not directly on filarial infection that such a condition necessarily depends, but on some process which is usually initiated by filarial infection, but may be brought about by other means.

It is thus seen that chylous exudations are generally associated with obstruction or injury to lacteals or lymphatics, and that the milky appearance has, in some of the instances, undoubtedly been due to the presence of chyle, justifying the term chylous applied to them generally. These considerations would suggest the conclusion that chyluria is of a similar nature—a conclusion which is supported by the characters of the urine and its frequent association with one of the other conditions dependent on lymphatic obstruction, for it is unlikely that such frequently associated conditions would have a different causation. This view, that chyluria is dependent on admixture of chyle with the urine in a direct manner, by means of a fistulous communication between the lymphatics and lacteals in the lumbar region and the pelvis of the kidney, ureter, or bladder, is that advanced by Dr. Vandyke Carter, in 1862, previously to the discovery of the connection of the disease with filariæ in the blood and lymphatics.

It has since been established by a number of observers (1), that the endemicity of chyluria and filarial infection are the same; (2), that the habitat of the parent filariæ is the lymphatic system; (3), that in filarial-inhabited lymphatics there is a tendency to obstruction of the trunk of the lymphatic or of the glands to which it leads, with varicose dilatations and escape of the contents of the lymphatics, consequent upon such obstruction; (4), in a case recorded by the writer, the renal, lumbar, and iliac lymphatics were in a very varicose condition.

Dr. Patrick Manson has offered an explanation of the pathology of the various lesions associated with the presence of the filaria sanguinis hominis in the lymphatics and blood-vessels, having the merit of uniting a number of frequently associated conditions, which, whilst differing much in outward appearance, have the same geographical distribution. If his explanation appear fanciful and farfetched, it must be remembered that no one has done more to unravel the mystery pervading the subject, and that many of the phenomena connected with filarial infection are so strange as to seem incredible to those who have not studied the matter.

In ordinary circumstances the embryos of the parent filariæ situated in the lymphatic trunks are born with their chorional envelopes stretched, and are then of such dimensions as to be able to traverse the smallest capillaries (*see* Filaria Sanguinis Hominis). It has, however, been shown that occasionally ova escape from the female parent. The ova, with their unextended chorional envelope, are from five to seven times greater in their smallest diameter than the outstretched embryos, and their size, and perhaps absence of power of self-movement, render them too large to pass the delicate meshes of the lymphatic glands, where, acting as emboli, they plug the lymph-channel, and dam up the lymph or chyle. 'There will then be complete stasis in this particular vessel, as far back as the first anastomosing lymphatic. Along this the current will now pass, carrying with it other ova; these in their turn will be arrested at the first gland they reach. And this process of embolism, stasis of lymph, diversion of current into anastomosis, will go on until the whole of the lymphatic glands, directly or indirectly connected with the vessel into which the parent parasite ejects her ova, are rendered impervious, provided the supply of embolic ova is sufficient, kept up long enough, or renewed from time to time.' (Manson.)

If the *aborting parent* is in the lymphatic trunk of the pelvic or lumbar region, should the stasis caused by the ova involve the lymphatics of the kidneys, ureters, or bladder, chyluria may result, owing to a nævoid condition of these lymphatics discharging themselves into the urinary tract. If the discharge comes from a lymphatic reservoir, the result will be lymphous urine; if from a lacteal or from a lymphatic into which chyle has *regurgitated*, chyluria will result. Irregular pouchings and collections, which, when sufficiently distended, render the lymphatic valves incompetent, may be one of the factors in producing the irregularities in the characters of the urine in such cases. The essence of Manson's pathology is—obstruction of lymphatic trunks, stasis, dilatation of tributary lymphatics, rupture, and escape of contents. Whilst in the endemic cases, abortion of the female parasite may be the usual cause of the lymphatic obstruction that leads to the varicose condition and rupture of the lymphatics, *any other condition that leads to such obstruction* may be expected to be followed by similar results. It seems, moreover, probable to the writer that, even in filarial cases, it is not essential to invoke the premature escape of ova, but that the parent filariæ may by their presence excite inflammation of lymphatic trunks, and thus give rise to stasis. In non-filarial cases inflammation (from which it is known the lymphatics elsewhere are by no means exempt) excited by other causes, may be the explanation of the lymphatic obstruction; just as elephantiasis of the lower extremities is sometimes caused in persons who have never been abroad, by injuries that lead to inflammation and obliteration of the lymphatic trunks of the thigh. Anatomical proof is still wanting as to where the communication is established between the lymphatic system and the urinary tract. In a case recorded by the writer, the iliac, lumbar, and renal lymphatics were greatly dilated.

In a case recorded by Dr. W. Roberts, the communication was probably in the bladder, and the condition was ascribed to a nævoid state of the cutaneous and subcutaneous lymphatics, some of the varicose enlargements, on the surface of the skin, rupturing and discharging their contents externally, whilst others discharged their contents into the bladder. One other explanation has been put forward by Claude Bernard and Ch. Robin, viz. that a piarrhæmic condition of the blood is present, and that the kidneys merely eliminate the fatty matter. Robin has further suggested that this state of the blood, natural after meals, is rendered more or less permanent by some derangement of the digestive organs, especially the liver, by the filaria sanguinis hominis. But whilst some analyses of the blood have shown fatty matter in excess, others, as those by Bence Jones and Crevaux, have shown that no such excess of fat in the blood has existed in cases of chyluria. Moreover, as Dr. Roberts writes, 'it is incredible that blood-albumin and fibrin should pass from the blood into the urine through the kidneys, without being accompanied by casts of the uriniferous tubes.'

In cases in which post-mortem examinations have been made, no structural alterations have been found in the kidneys. Filariæ have been found in the blood-vessels, arteries, and veins, to their minutest ramifications. Careful examinations and injections of the lymphatics are much to be desired where the opportunity is afforded.

Symptoms.—There are usually no proper premonitory symptoms. Sometimes the disease sets in insidiously, but more usually it makes its appearance abruptly, the first indication of the malady being that the urine is noticed to have a milky appearance. Sometimes the attack is ushered in with hæmaturia, and in many cases hæmaturia is present to a greater degree than is accounted for by mere lymphatic, or lacteally-developed, blood-corpuscles. This admixture with blood, which has led some to designate the disease 'hæmato-chyluria,' appears to be more common in Egypt, the Brazils, and the West Indies than in the cases of the disease seen in India and China. Lewis suggests that it may be due to some specific difference in the parasites causing the urinary disorder in the different countries.

In one or other of these ways, the urine acquires a milky appearance. There may be few or no general symptoms accompanying the chyluria, but local symptoms, such as pain or uneasiness across the loins, are sometimes complained of, pain may be felt along the ureters and in the bladder, and, in the male, in the perineum. This is especially the case where coagula form in the bladder, when micturition may be impeded or obstructed. In such cases, in the male, long cylindrical coagula, moulded in the urethra, are sometimes passed with relief to the obstruction. There are sometimes marked debility, depression, and wasting; but the chyluria may occur with the appearance and feeling of perfect health. There may co-exist with the chyluria, lymph-scrotum, and elephantiasis of the scrotum or lower extremities, with chylous discharges from the surface of the body. In filarial cases, irregular attacks of pyrexia are prone to occur—'filarial' or 'elephantoid fever.' These feverish attacks, sometimes mistaken for ague, differ from the latter in the irregularity of the fever and intermissions. In most cases the blood taken from a prick at any part of the surface of the body is found to contain embryo filariæ in an active moving condition. In order to detect their presence, the examination should be made at *night*, on account of their periodical appearance in, and disappearance from, the circulation. *See* Filaria Sanguinis Hominis.

Characters of the Urine.—The urine sometimes looks like milk, sometimes like a mixture of milk and blood. It has a sweet, and sometimes a milk-like, or whey-like smell, when freshly passed, especially on being warmed, but it soon becomes fœtid. When allowed to stand, a cream-like layer often rises to the surface, and the remainder of the fluid, after a short interval, sets into a blancmange-like jelly, which, after remaining in this condition for a few hours, spontaneously disintegrates, a few filmy coagula, containing blood-corpuscles, floating in the fluid, and a deposit, looking like blood, falls to the bottom of the vessel. The quantity of urine is almost invariably increased to 70, 80, or 100 ounces in the twenty-four hours. The specific gravity is generally below normal. The reaction is neutral or faintly alkaline. The ordinary constituents of urine are present, generally in natural proportions, except the water, which is increased. Albumin is always present, generally in considerable quantity, and is coagulated by heat, nitric and picric acids. Peptones, and a trace of indican have been found in the urine (Ralfe). Sugar is absent in uncomplicated cases. Casein has not been found. The clot has the property possessed by fibrin, of decomposing peroxide of hydrogen with effervescence. When the milky urine is shaken with ether in a test-tube, the fatty matter rises to the surface, leaving the urine clear or slightly opalescent. The ethereal extract, on evaporation, yields a solid or oily uncrystallisable fat, partly saponifiable, resembling that found in the blood.

In some cases the urine is *lymphous* rather than chylous; that is, it contains albumin and coagulates spontaneously; but the fat is absent, together with the opaque milky appearance which depends thereon. The coagulum in lymphous urine resembles calves-foot or currant jelly (Roberts).

Many analyses of the urine have been made in chyluria. The following by Brieger of the night urine are valuable for their completeness:—

	Maximum in 100 parts	Minimum in 100 parts
Fats	0·725	0·06
Albumins . . .	0·798	0·581
Urea	3·4	3·7
Uric acid . . .	0·03	0·03
Sodium chloride . .	1·7	1·4
Sulphates . . .	0·22	0·23
Quantity of urine .	400 cc.	300 cc.
Specific gravity . .	1·016	1·025

Microscopical examination of chylous urine shows finely granular, fatty matter (molecular basis of chyle), oil-globules in some, but not in all, cases, especially in the creamy layer that rises to the surface; corpuscles resembling the white corpuscles of the blood and lymph; red blood-corpuscles of various sizes and stages of development;

and, in most cases, embryo filariæ. As a rule, with scarcely any exceptions, no renal casts are present. Occasionally urinary crystals, as oxalate of lime, are found, and, when the urine has been kept for any time, putrefactive bacteria will probably be discovered. The embryo filariæ are found alive and dead. They probably do not live long in the urine when passed, owing to its decomposition. In order to detect them, any portion of clot which is blood-coloured should be placed on a slide and examined, or the coagula in the urine may be broken down by stirring, and the deposit removed after subsidence, but they also occur in the free deposit in some instances.

The degree of milkiness of the urine varies in different cases, and often in the same case at different times. In most cases it is much more chylous after meals than at other times, but this does not obtain in all. In some cases the urine is most chylous in the daytime, but in others, that passed on rising in the morning is most milky. In some cases, rest, position, and exercise appear to influence its characters; but, as Dr. Roberts writes, irregularities in regard to meals, exercise, and rest are inextricably contradictory.

Progress and Duration.—In some cases the disease persists with little variation for years. In the majority of cases, after lasting an indefinite time, it spontaneously ceases, or appears to yield to treatment; but after the patient has remained free from the malady for months or years, it becomes re-established without any explanation of its recurrence. The urine has been known to be milky on one or two occasions only, and its chylous character has persisted for upwards of fifty years. The intermissions have sometimes appeared to be due to independent illnesses or shock, but in other cases no such influence could be traced. In the majority of fatal cases, death has been brought about by intercurrent diseases. Dr. T. Lewis remarks: 'Patients, in apparently good health otherwise, have been known to die very unexpectedly from no recognised acute disorder.' The case recorded by the writer in the *Pathological Society's Transactions* affords a probable explanation of such terminations, the fatal issue in this instance apparently being due to the local consequences of the death of the parent filariæ in the abdominal and thoracic lymphatics.

Diagnosis.—As a rule no difficulty is experienced in the recognition of the disease, but the practitioner must bear in mind the possibility of the intentional or accidental addition of milk to the urine after it has been passed. In true chyluria, the urine always contains albumin and fibrin. Owing to coagulation of the urine within the bladder, micturition may be interfered with, and the case come under the care of the surgeon on this account. In one case under the care of the writer there had been cystitis at the commencement of the attack. Whilst the disease is usually to be traced to filarial infection, it must be borne in mind that chyluria may continue in cases where filariæ have ceased to be present in the blood or urine, and that it does occasionally occur in persons in whom there is no reason to suppose that they have ever existed.

Prognosis.—The prognosis will have been gathered from the account of the progress and duration of the disease. The irregularity of its course, and its liability to recurrence, render the prognosis quite uncertain in any individual instance. In cases in which filariæ are found in the blood, the possibility, however remote, of a rapidly fatal termination must be remembered.

Treatment.—No plan of treatment offers any certainty of cure. Whilst rest in the recumbent position is sometimes of decided benefit, it is too uncertain in its effect, and too irksome to the patient, who often feels well in other respects, to be always willingly submitted to. It is worth trying, however, when practicable. Dietetic treatment—the exclusion of all fatty substances—may lessen the milkiness of the urine, but will scarcely benefit the patient. No drug exercises a positively specific influence, though the mangrove bark (Rhizophora racemosa), and the seeds of Nigella sativa (a constituent of curries), enjoy local reputations. Theoretically, antiparasitic remedies appear to be indicated in cases where filariæ are found to be present; but in the first place, no remedy of this class appears to have been successfully employed, and in the second place it is not certain that the disease would be cured even if the parasites that initiated the chyluria could be destroyed, for, as already stated, the malady sometimes persists when filariæ which were present at one stage of the disease have disappeared from the blood and urine. Moreover, some good authorities are of opinion that the death of the parent worms in the lymphatics, if it could be accomplished, is by no means devoid of danger. Astringents, mineral and vegetable, are sometimes of at least temporary benefit, especially perchloride of iron in cases where there is much anæmia, and gallic acid. The latter is chiefly trusted to in India, and may be given in doses of one or two drachms a day. Iodide of potassium has also appeared of occasional service. The writer has seen in three cases very striking benefit from benzoate of soda, in doses of from twenty grains to two drachms three times a day. Under this treatment the milkiness of the urine has been greatly diminished, or has disappeared; and, what is of importance, coagula have ceased to form in the bladder. He has not, however, been able to follow out any case for a sufficient period to ascertain how long these good effects are maintained. *See* Filaria; Elephantiasis Arabum; Lymph-scrotum. Stephen Mackenzie.

CICATRICES, Pathological Conditions of.—It is intended in this article to deal with the deformities caused by cicatrices, and with the abnormal conditions and pathological affections of scar-tissue.

Discolouration of Scars.—A cicatrix may become discoloured through the inclusion within its tissue of some foreign material. The best known instances of this staining are presented by scars formed after gunpowder injuries, and by the corneal opacity that sometimes follows the application of nitrate of silver to an ulcer of the cornea. It has been asserted by Nélaton that an indelible stain may be caused by the application of black court-plaster to a small healing wound.

In old cases of chronic and varicose ulceration of the leg the scar and surrounding skin are often marked on the surface by patches of deep brown pigmentation. The scars formed on the healing of syphilitic ulcers present for a time a coppery-red colour, and subsequently become unnaturally pale. Large strumous ulcers are replaced by uneven scars of an unsightly livid tint, and traversed by prominent bands.

Deformed Scars.—The scar of an ulcer associated with necrosis or caries of bone is usually very dense, depressed, and closely connected with the previously diseased bone, and, when present in some exposed region, as on the forehead, causes much disfigurement. Extensive cicatrices of long standing, which have been formed over the inner surface of the tibia after necrosis, often become very dense and of almost cartilaginous hardness. As good instances of the deformity and mischief likely to be caused by adherent scars may be mentioned cicatricial ectropion after bone-disease, and cicatricial closure of the jaws.

The so-called *exuberant* or *deformed cicatrix* due to excessive formation of scar-tissue is a frequent result of tardiness in the healing of a granulating surface. It is very often met with after scrofulous and lupoid ulceration and after a deep burn. Under this heading may be ranged the numerous varieties of hypertrophied scar, from the small lumpy growths mentioned by Sir James Paget, as occasionally observed after the operation for hare-lip and a vertical wound through an eyelid, to the thickened masses closely resembling keloid growths which are sometimes formed over large and multiple cicatrices.

Cicatricial Deformities.—Deformities caused by dense retractile cicatrices occur most frequently after very severe and extensive burns. The following are the different forms of cicatrix by which deformity may be produced:—(1) The *broad and expanded cicatrix* met with in most instances in front of the neck. This usually consists in a thick parchment-like membrane of a light colour, and mottled on its surface with yellow or brown spots. The surface is uneven and marked by intersecting ridges. In consequence of the retractile action of this scar on the movable skin of the face, the lower lip and the lower eyelids are dragged downwards. The lower jaw is also depressed towards the top of the sternum; and in old cases the shape of this bone is much altered, and the front teeth project forwards. Among the many troublesome results of such a condition is a constant flow of saliva, causing irritation and superficial ulceration of the scar. (2) The *narrow cicatrix* extending like a tight cord or riband from one part of the surface to another, and forming the so-called 'vicious bridle.' This is met with most frequently in the upper extremity, extending across the axilla to the arm, or from the arm to the forearm in front of the elbow. (3) A very frequent form of cicatricial deformity is that caused by the *scarring of adhesions* formed between contiguous and approximated parts. Cases have been observed of adhesion of the scrotum to the inner surface of the thigh, of the mamma to the front of the chest, of the pinna to the side of the head, and, after scalding, of the inner surface of the cheek to the gums. The most frequent instances, however, of this deformity are the adhesions of fingers and of toes after burns of the extremities. (4) The *depressed cicatrix* which is the result in most instances of a severe burn, which, without involving much of the surface, has extended deeply into the limb. In this form of cicatrix the skin may be tightly bound down to the surface of a bone, and the muscular and other soft parts be much constricted. *Cicatricial contraction*, extending in some instances to almost *complete obliteration of a natural orifice*, as the mouth, anterior nares, and orbital aperture, is the result partly of adhesion of the burnt or ulcerated margins of the opening, and partly of concentric retraction of the surrounding scar.

In the *treatment* of cicatricial deformity the surgeon may either practise *extension* or *compression* of the scar, or these two methods combined, or have recourse to some cutting operation. If properly applied in suitable cases, extension tends to elongate and unfold the cicatrix, and compression to cause absorption of some of the special retractile material of the cicatricial tissue. Each method must be applied with great care, and demands, as a condition of success, much patience and perseverance. If the extension be used with sudden force the cicatrix may be torn, and serious inflammatory mischief, with ulceration, be set up. The agents used in extension are a specially devised collar for a large cicatrix in front of the neck, hinged splints moved by screws or cogwheels for cicatricial bands of the upper extremity, and weights in the rare instances of contraction from scars over the hip or knee. Compression is best applied by strips of plaster, and, over these, elastic bandaging.

The following are the principal methods of operative treatment:—(1) *Simple subcutaneous dissection*, by which the adhesions of a broad cicatrix to subjacent soft parts are divided. (2) *Incision*, either by one single cut across the cicatrix, or by a number of small cuts, the distorted parts being at once restored, as far as possible, to their normal position, and one large open surface or several small wounds being formed. (3) *Division of the cicatrix*, relief of the distortion, and immediate closing of the wound by bringing its edges together in a line at right angles to that taken by the knife. (4) *Excision of the scar*, with approximation of the edges of the gaping wound by interrupted or quilled sutures. (5) *Loosening of cicatrix*, by incision of sound skin, either above or below, and by subcutaneous dissection. (6) *Plastic operations*, consisting in either simple division or complete removal of the cicatrix, and in completely or partially covering the open surface thus formed with a flap of skin taken from a contiguous or remote part of the surface of the body.

The indications and the special advantages of each of the above-mentioned methods of treatment may be thus briefly stated.

Mechanical extension associated with direct pressure by means of elastic bandaging and plaster, and with occasional manipulation of the cicatrix, will produce partial absorption of the retractile tissue, render it more pliant, elongate the bands, and, consequently, favour the restoration of distorted parts to their normal position and mobility. This non-operative treatment is applicable to a large class of cases. Most broad and membranous cicatrices which are not very thick, and not closely attached by their under surfaces to fasciæ, muscle, or bone, are more or less amenable to long-continued stretching and pressure. Where extension is applied, an essential condition of success is the presence of sound and dry integument above and below the cicatrix, for the extremities of the stretching apparatus to rest upon.

Simple incision or division of a large cicatrix produces immediate relief, which, however, does not remain permanent. The large open surface contracts as it heals, and the temporarily relaxed parts are gradually brought to their former abnormal position.

The method of multiple small incisions acts very effectually in many cases, but generally in those which are as readily amenable to non-operative treatment.

Excision is a valuable method in cases of small scars, and of long, narrow, tendon-like bands that are not very salient, but is ineffective and dangerous in any case of deformity produced by a thick and broad cicatrix.

Incision, associated with submembranous dissection and partial detachment of the cicatrix, generally produces great and marked relief, and, in some instances, complete cure. A very prolonged and wearisome course of after-treatment, however, is necessary in order to control the retractile action of the newly-formed cicatrix, and to prevent renewal of the deformity.

Autoplasty, when well-planned and successfully performed, is less likely than any other method to be followed by any return of the deformity, as the retractile structure is replaced by a flap of supple and extensile skin. This method may be applied with good prospect of success to many cases in which the cicatricial deformity is too severe and extensive to be treated effectually in any other way. *See* Cheiloplasty.

Painful Scars.—As a general rule the surface of a sound scar is much less sensitive than that of the adjacent integument, and the thickened scars and the tight and dense cicatricial bands, formed after severe burns, are usually quite insensitive. The subjects of some large scars, however, and especially of extended patches of thin and pale scar-tissue on the back and shoulders, often complain of itching or burning sensations over the seat of the old injury, but most intense near the junction of the cicatricial tissue with the healthy skin. In most instances these attacks come on very irregularly, and are most severe during damp weather.

A more troublesome affection is what has been called *neuralgia of scar*. This is characterised by severe burning pain, which, in some cases, is limited to the scar, and in others radiates along the nerve-trunks of the affected limb or region. These neuralgic pains, which may be either paroxysmal or persistent, occur most frequently in cases of irritable stump, and in tense and depressed scars. When persistent, the pain is very often due to squeezing or stretching of the extremity of a nerve by retractile cicatricial tissue, or to compression of the nerve between bone and a tense and depressed scar. In many cases, however, of neuralgic scar, especially those in which the pains are paroxysmal, the cause of the affection is very obscure. *See* Stumps.

The itching sensations in scars, often so troublesome during changes in weather, are not as a rule very amenable to treatment. In some cases warmth, in others cold, gives relief. When painful, the scarred surface should be covered by a layer of some dry, warm, and very soft material, such as cotton-wool. A broad, painful scar, if much exposed to the friction of underclothing, should be protected by simple plaster or emplastrum opii. In cases of more severe cicatricial pains, the local application of chloroform, or of vinum opii and glycerine, or a subcutaneous injection of morphia, will afford some relief, trial being made of quinine in large doses during any attack of a paroxysmal character. In the treatment of neuralgic pains causing much and constant suffering, attempts may be made to effect a cure by cauterising or excising the scar if small; by dividing subcutaneously any adhesions that may exist between the scar and bone or other deep parts; by neurectomy; by nerve-stretching, or by excision of the extremity of the affected nerve.

Ulceration. — Cicatricial structure, though imperfectly organised and not freely supplied with blood, seldom ulcerates, except it be subjected to much violence or continuous irritation; or, together with the surrounding normal structures, it be involved in some local inflammatory action, or some disturbance of the circulation. The most frequent examples of cicatricial ulceration are the breaking down of the scar of a chronic ulcer of the leg, associated with more or less varicosity, and the rapid disappearance of a very recent and thin scar under the influence of an attack of erysipelatous inflammation. During the healing of an extensive burn there is a constant tendency in the newly-formed scar to inflame and ulcerate. The scars most liable to ulceration are those which adhere to bone, and those tightly stretched in the form of prominent bands between two segments of a limb. A slight laceration, or a scratch even, of a large and stretched scar may become the starting-point of extensive ulceration.

In cases of ulceration of scar-tissue, an endeavour having been made to remove all sources of further irritation, the affected part should be kept at rest, and the open surface be treated as an ordinary wound or ulcer.

Epidermic Growths. — Simple warts sometimes grow from cicatricial tissue, particularly of a depressed scar between two bulging flaps of a stump. These are generally the result of inattention to cleanliness. Epidermic growths are occasionally seen on the scars that result from cauterisation of the skin, where they form small conical or pyramidal eminences, resembling in appearance ordinary corns. Sometimes a long thin horn grows from the surface of a scar. Hutin related a case in which a horn two inches in length had grown from a scar produced by the actual cautery. A portion of the cicatricial tissue extended far into the centre of this horn, which was vascular and tender on section.

Keloid.—Keloid growth of scar-tissue (*keloid of Addison*, *false or cicatricial keloid*) usually presents itself as a firm, elevated tumour, with rounded and sometimes overhanging margins, from which spur-like processes pass into the surrounding healthy skin. The surface is smooth and glossy, in some cases of a red or pink colour, in others quite white. A few small vessels may usually be seen running over the growth, and some thin hairs may be scattered over its surface. The tumour, when large, is usually marked in its central parts by one or more distinct depressions. It is slightly tender when handled, and in some cases, particularly at an early stage of growth, is the seat of itching or stinging sensations. Keloid consists in a circumscribed tumour, the cut structure of which has the appearance of a firm fibroma, and presents under the microscope very closely packed bands of fibrous tissue, running for the most part parallel to the surface of the growth. It may be developed in any variety of cicatrix, from the extensive and thick bands formed after a severe burn, to the almost imperceptible mark of a leech-bite. It has been observed in the scars of small-pox, herpes zoster, acne, and syphilis, and may come on, it has been stated, in the seat of a blister, or even after a contusion without any lesion of the epidermis. A case has been recorded by Verneuil in which the conjunctivæ of both eyes were affected with small keloid growths formed after the caustic action of strong sulphuric acid. The most frequent starting-points are the cicatrices of syphilitic ulcers, of burns, and of wounds caused by flogging. There seems to be a marked predisposition in coloured people, particularly Africans, to keloid, as well as to other morbid growths of scar-tissue. Instances observed by Dr. Goodhart and Mr. Clutton prove that keloid tumour may grow on different regions of the same patient, and in scars of varying form and origin, either simultaneously or in successive crops. It is probable that there may be a family tendency to keloid. It occurs most frequently in adults, but is not rare in young subjects. In one of a series of cases collected by a committee of the Clinical Society in 1879, the disease had been first observed at the age of six months, and in two other cases at the age of twelve months. According to Kaposi it occurs as frequently in males as in females.

Until recent years keloid was regarded as a permanent disease. The almost general opinion of those who had had much experience of this growth was, that after having slowly and steadily increased up to a certain point, it ceased to undergo any further change, and remained stationary during the rest of the patient's life. Cases have been recorded in which keloid had existed for ten, thirty-six, and forty years. Of late, however, an opinion has gained ground in this country that, as a general rule, keloid growths have a tendency to undergo spontaneous involution, and to disappear.

Excision of keloid is almost always followed by speedy relapse and the formation of a larger growth. Cauterisation, blistering, and the local application of iodine afford very slight prospect of success. Any neuralgic pain that may be associated with the disease is best treated by subcutaneous injection of morphia.

FIBROMA.—Very closely allied to keloid growths are the fibrous and myxo-fibromatous tumours of the external ear, which have been often observed, especially in coloured people, on lobules that have been punctured for the passage of ear-rings. These, though larger and of more rapid growth, present very much the same appearance and structure as keloid, and, as has been shown by Dr. Turnbull of Philadelphia, have a tendency to recur after removal.

MALIGNANT GROWTHS.—Cicatrices, like other forms of imperfectly-developed tissue, occasionally become the seat of malignant or semi-malignant growths. Some few cases have been recorded of medullary and melanotic sarcoma of small scars. The most frequent form, however, of cicatricial malignant tumour is the so-called 'warty growth of scar,' first described by the late Mr. Cæsar Hawkins in 1855. The usual seat of this growth, which in most instances is a papillary epithelioma, is a very old scar formed after a burn or flogging, or the scar of a chronic ulcer. It has been observed on the back, scalp, and heel, but most frequently either in a tense cicatricial band, extending from the arm across the axilla, or on a scar over the shin. Several instances have been observed of a less malignant form of warty growth, the precise structure and nature of which seems to be still undetermined, but which, in the opinion of Follin, is an ulcerating form of keloid.

W. JOHNSON SMITH.

CILIARY BODY, Diseases of the.—The ciliary body consists of the ciliary muscle, the ciliary processes, and the part of the choroid anterior to the ora serrata. In contact externally with the sclerotic, it forms a zone of about 6 mm. in breadth, measured in a meridional direction from the sclero-corneal margin. This part is called the ciliary region. On the inner surface of the ciliary body is the pigmented uveal layer, which becomes anteriorly the ciliary processes, and is continuous posteriorly with the pigment layer of the retina. The iris, the ciliary body, and the choroid are intimately connected by nervous and vascular supplies; they form, in fact, one continuous layer—the tunica vasculosa, or uveal tract. On account of this close anatomical relation, disease of any one of these structures has a great tendency to spread to the others.

Inflammation of the Ciliary Body (*Cyclitis*) is recognised by the following characters:—There is a zone of congestion surrounding the cornea, due to dilatation of the anterior ciliary vessels, underlying the conjunctiva (ciliary congestion). There is slight photophobia, lacrymation, and ciliary neuralgia. There is also tenderness, often confined to one spot, on pressing the finger over the ciliary region: this marked pain on pressure being a distinguishing feature of cyclitis. The disease has a tendency to recur, to attack one part of the ciliary body more than another, and to produce secondary changes in neighbouring structures.

There are certain cases which indicate, both in their clinical and pathological features, that the inflammatory changes commence in the ciliary body; these will be described first. Cyclitis may also be secondary to iritis, but it is often impossible to say, especially in the later stages, where the primary seat of the disease was situated.

Serous Cyclitis begins with pain and tenderness over the ciliary body, and with ciliary congestion: the pupil may be dilated, but the iris is otherwise little affected; keratitis punctata soon appears; opacities form in the anterior part of the vitreous, producing some diminution of vision. After several attacks of this character, adhesions form between the iris and the lens-capsule, but only at the pupillary margin, followed, in severe cases, by complete exclusion of the pupil, a bulging forward of the iris, and secondary glaucoma. Glaucoma may, however, appear quite early in the disease, before the iris is much affected. In some instances the disease runs a mild course, the iris being wholly unaffected.

Treatment consists in giving the eyes complete rest and in keeping the pupil dilated with atropine. An extensive iridectomy may be performed if the disease persists for long, and is especially demanded when there is any increased tension, with or without exclusion of the pupil.

Cyclo-iritis (*irido-choroiditis*).—In this, as in other forms of cyclitis, the inflammatory changes vary in intensity. They are plastic in character, and are seldom limited to the iris and ciliary body.

A distinct group of cases (*anterior choroido-sclerotitis* which ends in anterior or ciliary staphyloma) take the following course:—At one or two circumscribed areas of the ciliary region there occur repeated attacks of sub-conjunctival congestion, accompanied by pain and tenderness. The area of congestion is sharply limited. The attacks last for several weeks, and are followed by intervals of complete freedom from inflammation. Eventually a slight bulging of the sclerotic at one spot is noticed, and, with each exacerbation, slowly increases. Here the sclerotic becomes thin and of a dusky colour, the choroid and ciliary body showing through it. The neighbouring part of the cornea becomes opaque, and posterior synechiæ are formed. In the later stages the whole of the anterior part of the sclerotic becomes one large staphyloma, the cornea is stretched and enlarged, the iris and ciliary body atrophied. The disease is essentially of a chronic nature, and is often completely arrested for long periods.

This form of cyclitis is very intractable under treatment. The application of the artificial leech and blistering to the temple, combined with the use of atropine, in some cases cuts short the attacks. Other cases are improved by a course of mercury. An iridectomy is sometimes of great value, and may completely arrest the disease.

Cyclo-iritis, in some of its most destructive forms, is more acute, and may commence in the iris or ciliary body, or in both together. A plastic exudation from these two structures gradually envelopes the lens, producing occlusion of the pupil, with total posterior synechia. The lens becomes cataractous, and a cyclitic membrane forms behind it. Early in the disease there is great deterioration of sight, with secondary glaucoma, and a shallow anterior chamber. Later, with shrinking of the vitreous, the eyeball becomes soft.

The exciting cause is sometimes syphilis, either hereditary or acquired. In hereditary syphilis the cyclitis occurs with interstitial keratitis; in acquired syphilis, during the secondary stage. It is in some instances a complication of rheumatic iritis, in many its causation is obscure.

Constitutional treatment, especially in the syphilitic cases, is of the utmost importance. Ciliary tenderness and neuralgia may be relieved by hot fomentations and counter-irritants; local treatment, however, is unsatisfactory. It is impossible to perform an iridectomy with any success, as the iris is very friable, and is firmly bound down to the lens-capsule.

Sympathetic Irido-cyclitis almost invariably begins with serous iritis, soon developing into the most severe form of plastic irido-cyclitis. Some cases never proceed beyond the stage of serous irido-cyclitis, and run a mild course. *See* SYMPATHETIC OPHTHALMITIS.

The ciliary body is sometimes the seat of a *syphilitic gumma*. If the gumma breaks down, a perforation of the ciliary region, with destructive inflammation of the eyeball, may ensue.

A *tubercular growth* in this situation produces great inflammatory swelling of the ciliary body, and is usually accompanied by similar deposits in other parts of the eye.

Injuries of the Ciliary Body.—Blows on the eye sometimes induce paralysis of the ciliary muscle, with dilatation of the pupil and loss of accommodation. Recovery usually occurs in a few days. Hæmorrhage into the anterior chamber or vitreous may also be due to a blow, from rupture of one of the bloodvessels of the ciliary processes. Punctured wounds of the ciliary region are especially dangerous, because traumatic cyclitis may result, and also because an injury of this part of the eye is the chief exciting cause of sympathetic ophthalmitis.

Traumatic Cyclitis is, in the great majority of cases, purulent in character, and is recognised by considerable swelling of the lids, with pain, great tenderness, and congestion of the ciliary region. The aqueous becomes muddy, and pus covers the ciliary processes and the posterior surfaces of the lens, being seen as a yellowish mass through the pupil. This purulent cyclitis is accompanied by diminished tension of the eyeball.

Certain *functional* disturbances of the ciliary muscle are to be noted.

Paralysis of the ciliary muscle alone (cycloplegia) often follows diphtheria, and usually in hypermetropic eyes. Combined with dilatation of the pupil it occurs in complete paralysis of the third nerve; finally, all the internal muscles of the eye may be paralysed (ophthalmoplegia interna). Paresis of accommodation may be the result of debilitating disease, or of overstraining of the ciliary muscle. Spasm of accommodation is sometimes found in hypermetropia. In hypermetropia the circular fibres are often greatly developed, whilst in myopia they are wanting. This, however, is far from being an invariable condition. *See* Accommodation, Disorders of, and Refraction, Errors of.

Atrophy of the ciliary body results from any prolonged pressure applied to it, and is always well-marked in glaucoma of any standing; it is also found in staphyloma of the ciliary region.

The *tumours* of the ciliary body are leuco- and melano-sarcoma. *See* Orbit, Tumours of the.

Coloboma of the ciliary body is a congenital cleft of the lower part, accompanying coloboma of the iris and choroid.

W. J. Milles.

CIRCUMCISION.—The operation of circumcision, or removal of a portion of the prepuce, may be required in the following cases:—

1. To remedy the constitutional and local irritation produced in infancy by an abnormally long prepuce.
2. To prevent the recurrence of balanitis (*see* Balanitis) in lads, produced by the retention of the secretions beneath a long and tight prepuce.
3. To relieve a phimosis produced by balano-posthitis, or by the suspected presence of a phagedænic sore beneath the prepuce.
4. To remove the irritation and difficulty in micturition sometimes present in old men as the result of a long prepuce with contracted orifice.

The usual method of performing the operation in children is as follows:—A tape should first be tied tightly round the root of the penis (a most efficient and simple plan), or Clover's circumcision-tourniquet may be applied, to prevent all hæmorrhage during the operation. The exact length of skin to be removed must then be calculated, either by marking, with an indelible pencil, the skin as it remains *in situ*, at a line corresponding to the corona glandis; or by applying a pair of long polypus-forceps to the same point, and closing them firmly on the skin, as soon as the glans penis has slipped back from between the blades. The forceps should be applied at the point selected obliquely from above downwards and forwards. The portion of skin beyond the forceps is then cut off with a single sweep of a long bistoury, or, better still, with a pair of curved scissors. On removing the forceps it will be found that, whilst the skin has retracted considerably, the mucous membrane still embraces the glans. This must be slit up with scissors well back to the corona, and the angles of the flaps be rounded off. The mucous membrane should then be turned back, and its edge adjusted to that of the skin. Before doing so it is well to secure the mouths of any vessels that can be seen with fine catgut ligature, but in infants this is seldom needful. The edges of the mucous membrane and skin having been neatly adjusted should be kept *in situ* by a long strip of dry lint six or eight inches long and half an inch wide, applied as follows:—

The glans being well pulled forward by an assistant, the middle of the strip of lint is applied to the under surface of the penis immediately behind the glans. The two ends are then passed over and around the organ in successive turns, until the root is reached, when they will lie crossed on the lower part of the abdomen, and must be secured in that position by a couple of strips of adhesive plaster.

The advantages of this method of dressing are that the orifice of the urethra is left free, the cut edges of the mucous membrane and skin are retained in apposition, and the child is unable to pull off the dressings. The tape at the root of the penis should not be removed until this dressing has been applied. It will be observed that no mention of sutures has been made. The fact is that in infants and young lads they are quite unnecessary. If they are used they should be of the finest catgut, and should be placed as near as possible to the edges of the skin and mucous membrane. Such sutures require no removal. The old method of bringing the parts together with a number of silk or wire sutures frequently entailed the second administration of an anæsthetic during their removal. A not uncommon difficulty met with during this operation is the adhesion of the prepuce to the glans penis, especially in the neighbourhood of the corona. Generally these adhesions are easily overcome, but they are occasionally somewhat tough, and require to be broken down with a probe or director. At any rate they should be thoroughly divided, and the prepuce peeled back, so that the furrow behind the corona glandis is distinctly defined.

The after-treatment is of the simplest. The patient must remain in bed for a few days, and the bed-clothes should be kept off the parts by a cradle. On the fourth or fifth day it will be necessary to remove the dressing, and this is most easily accomplished by placing the patient in a warm bath and letting the parts soak for some time. On the removal of the lint it will be generally found that the wound has for the most part healed by first intention. That portion which has not done so will soon fill up by granulation, with little or no distress to the patient. During this process the parts should be protected by a strip of lint spread with vaseline or zinc ointment. A certain amount of œdema, especially in the neighbourhood of the frænum, remains for some weeks after the operation. Although this operation is one seldom attended by danger to life, yet there are cases on record of death from erysipelas and from hæmorrhage after its performance.

In adult cases where the prepuce is not elongated, but the orifice is contracted, the slitting operation will suffice. This may be performed by passing a director underneath the prepuce, and slitting it up with a curved, sharp-pointed bistoury; or a pair of strong, sharp scissors may be used. In either case the incision should be made on the dorsum, and care should be taken to slit the mucous membrane well back to the corona. If the prepuce is elongated a portion should be removed with scissors, the parts being put on the stretch by an assistant taking the two cut angles with a couple of fine spring forceps. These angles should then be rounded off. All vessels must be tied with fine catgut, and the edges of the skin and mucous membrane united by several sutures of the same material.

The wound should then be dressed with a strip of lint soaked in carbolic oil (1–20). The sutures, if any of them require removal, may be taken out on the third or fourth day.

PAUL SWAIN.

CIRSOID ANEURISM.—*Definition.* A tortuous and dilated condition of the medium-sized and smaller arteries of a part, extending to the smallest branches, where it terminates in a central pulsating tumour. The vessels especially predisposed to the disease are the branches of the external carotid artery distributed to the scalp; but the arteries of the extremities, scrotum, and trunk are not infrequently the subject of attack. The so-called 'aneurism by anastomosis' of the orbit rarely belongs to the same category.

Etiology.—The conditions which predispose to, or excite, the disease are ill-understood. The tumour generally makes its appearance in early childhood, but may be congenital in origin, or may not appear until adult life. As a rule no cause can be demonstrated, but the morbid changes occasionally extend from a pre-existent nævus, or a more or less satisfactory history of local injury may be forthcoming.

Symptoms.—In a typical case cirsoid aneurism appears as a pulsating tumour fed by a number of dilated tortuous arteries. The tumour is usually moderately prominent, ill-defined at its periphery, somewhat lobulated on the surface, soft in consistence, reducible by direct pressure, and collapsing to some extent during compression of the main vessel. The superjacent skin may be thickened and of normal aspect, or atrophied and more or less transparent. The surrounding tributaries are contorted and irregularly dilated, gradually assuming their proper form and dimensions as they approach the main trunk. A thrill and *bruit de souffle* may be detected over the centre of the growth and for some distance along the course of the afferent vessels.

The whole of the tissues in contact with the diseased vessels undergo atrophic changes, and the subjacent bones may be deeply grooved or even perforated. The temperature of the parts does not usually differ perceptibly from the normal register, but an elevation of between 1° and 2° Fah. has been observed in one case. The affection is sometimes associated with a local neuralgia, but, as a rule, it is painless. The course is variable. In some instances the disease advances progressively from the first, while in others it may remain stationary for long periods, but usually tends to increase rapidly about puberty, or, in women, during pregnancy. In the latter stages hæmorrhages may become frequent and dangerous.

Pathological Anatomy. — The central pulsating tumour has been found to consist of a closely aggregated mass of dilated arterioles transformed into a kind of cavernous tissue by partial absorption of the contiguous walls of the component vessels. The intimate changes in the afferent arteries vary with the period of the disease. In the early stage the walls are said to be thickened, but after a time atrophic lesions supervene, and the tunics become thinned and irregularly dilated into a multitude of pouches. Traces of fatty degeneration have been discovered by some observers in the muscular coat (Labbé, Heine). The veins seldom display any marked changes, notwithstanding the vastly augmented capacity of the arteries.

The true nature of the morbid process is not fully elucidated by the visible alterations of structure. It is still uncertain whether the disease is to be regarded as an active ataxy with hyperplasia, according to which view it may be classed as a vascular neoplasm (Virchow); or whether the first link in the chain is a diminished resistance of the arterial wall, induced either by subacute inflammation (Billroth), or fatty degeneration (Robin, Labbé) of its tissues. It is possible that neither of these views need be rejected, but that some cases may be allied to nævus, in which they are occasionally found to originate; while in other instances a subacute arteritis, with implication of the nervi and vasa vasorum, may be determined by local injury, and of this condition fatty degeneration may be a later stage. Polaillon (*Bull. Soc. de Chir.* 1884) assumes that the essential feature of the disease is an abnormally free communication between the arteries and veins, and he believes the arterial changes to be secondary to this. The theory, however, does not touch the primary cause of the lesion, nor does it explain how such a condition, which would imply a lessened resistance to the flow of blood into the veins, operates in producing dilatation and flexuosity of the afferent vessels.

The *rôle* of local injury in the primary causation appears more important than has been hitherto believed, particularly when the early period of its development in most cases, and its very frequent localisation to the scalp, are borne in mind; the cranium not only being a part especially liable to damage in the course of parturition, and by falls during the first few years of life, but one in which the counter-pressure afforded by the bone would render the effects of contusion upon the vessels of the scalp more serious and lasting than in other localities.

Treatment.—There are few non-malignant affections in surgery which have proved more rebellious to treatment than cirsoid aneurism; but it is difficult to avoid the belief that the overwhelming list of failures is, in part at least, attributable to an imperfect conception of the nature of the disease, and to the consequent adoption of wholly inadequate measures for its removal. The problem appears to have been regarded as capable of solution by the same processes of reasoning that have been so profitably applied in the treatment of ordinary aneurism; but there are special features in the cirsoid tumour which so far remove it from surgical aneurisms that the means likely to afford every prospect of success in the latter case must almost assuredly fail in the first. In place of a diverticulum from the vascular wall, out of the direct line of the circulation, and offering conditions eminently favourable to the deposit of fibrinous particles from the blood and to coagulation of the fluid *en masse*, when the hurry of the current can be sufficiently moderated, we have to deal with a multitude of dilated vessels which, though tortuous and sacculated, retain a smooth lining throughout, and offer nothing to interrupt or retard the stream which courses rapidly through them to escape by the veins. Their calibre is always adaptable to the quantity of the circulating fluid, and hence there is no tendency to stagnation of blood, however much the flow becomes diminished in amount. Even the smallest rivulet would be sufficient to maintain the patency and vitality of the diseased vessels until the temporarily enfeebled circulation is restored to its full vigour by collateral supply.

In the treatment of cirsoid aneurism the efforts of the operator have been directed, in the greater number of cases, towards the arrest of the circulation through the focus of disease, either by ligature or acupressure of the individual afferent vessels, or one or more of the larger arteries. It is obvious, however, that in the case of a cirsoid tumour of the scalp it is impossible to secure every one of the tributary branches that converge towards the affected centre. To tie the external carotid leaves open not only all the mesial anastomoses, but many channels of communication with branches of the internal carotid, subclavian, and vertebral, any one of which would suffice to prevent any permanently beneficial result from the operation. Ligature of the common carotid removes only one of the sources of failure; ligature of both carotids brings us a step further, at a risk greatly in excess of the advantage gained; but it is only by tying every great vessel in the neck that the circulation in the tumour could be brought to a standstill. So far is the plan of treatment irrational that the sole cause for astonishment at the published results (which are not likely to be more unfavourable than the results withheld) is that, amid the host of failures and disasters, two or three successes have found a place. It is probable, however, that the cures in question were due to secondary inflammatory processes rather than to the immediate effects of the ligature.

The various methods of treatment may be classified as follows:—(*a*) Means intended to cut off the circulation through the tumour: such as acupressure of the aneurism and ligature or compression of the afferent vessels or large trunks. (*β*) Those which aim to induce coagulation of the blood in the dilated vessels: as galvano-puncture and injections of perchloride of iron. (*γ*) Those by which the whole of the affected tissues are destroyed: as caustics; and, lastly (*δ*), those undertaken for the entire ablation of the diseased part.

1. *Direct compression* of the tumour has not only been found useless, but is by no means free from danger.

2. *Ligature or acupressure* of the individual afferent arteries has been frequently practised, but with most unsatisfactory results. Out of 13 cases of cirsoid aneurism of the head, collected by Lefort, 11 are noted as failures with 2 deaths, and only 1 appears to have been completely successful (*Dict. des Sciences Méd.*).

Ligature of the larger trunks in similar cases has met with no better reward. Ligature of the external carotid has never succeeded. Of 24 cases of ligature of the common carotid, no less than 23 failures, including 10 deaths, appear against a single success: in two of the instances the operation was undertaken on account of secondary hæmorrhage following a useless ligature of the external carotid. In 9 cases of ligature of both common carotids, two cures are recorded, and the 7 failures included one death. The double operation in the well-known case of Mussey (*London Medical Gazette*, vol. viii.) had so little effect upon the circulation in the tumour, that when the latter was excised a few weeks afterwards the patient lost four pints of blood, and it was necessary to secure forty vessels. The analysis of 26 cases of cirsoid aneurism of the hand collected by Polaillon proves that here also operations upon the afferent vessels give only negative or uncertain results.

The statistics of ligature are so unfavourable as to be almost prohibitive of the operation as a means of cure, but as an adjunct to excision and some other measures it requires further consideration.

3. *Ligature of the tumour en masse*, when practicable, is a more scientific procedure, and has been carried out with success by Foubert and Bryant. Mr. Bryant records two cases, in one of which, however, the disease recurred four years afterwards, and was finally removed by excision. Lefort recommends that the afferent vessels should be secured, as a preliminary step.

4. *Destruction by caustics.*—This method of treatment is theoretically open to some objections, but in one case reported by Bonnet, in 1858, a cure followed the application of chloride of zinc paste over the afferent vessels and afterwards over the whole tumour.

5. *Coagulation of the blood in the diseased vessels.*—Electro-puncture has been successful in one case, and carefully applied in association with circular compression of the afferent vessels would involve but little risk if the needles be connected with the positive pole. Injection of perchloride of iron has been employed more frequently and with variable success. Out of 10 cases collected by Le Fort, 8 terminated in cure, but of the 2 failures 1 proved fatal from septicæmia; while Zielewitz records 6 deaths in 14 cases. It can only be performed safely in conjunction with circum-

ferential compression (continued for half an hour after the injection) or ligature of the afferent vessels. A solution of the strength of 5 per cent. to 10 per cent. would be suitable for the purpose.

6. *Removal by excision.*—This apparently formidable procedure is not only the most certain mode of cure, but, if carried out with due precautions, is comparatively free from danger. The ablation of a cirsoid aneurism of any size would, however, lead to enormous hæmorrhage, unless preceded by some measures for limiting the access of blood to the part. Hitherto the excision has rarely been performed except as a last resource after the afferent vessels or larger trunks have been tied without benefit, and under these circumstances, owing to the speedy establishment of collateral circulation, the advantages of the ligature are lessened in proportion to the time allowed to elapse between its application and the removal of the tumour. Thus, in Mussey's case, although both common carotids had been tied, the hæmorrhage was terrific when excision was performed a few weeks later. To secure the best results it would appear advisable that the ablation should be *immediately* preceded by the ligature or acupressure of every accessible tributary; the smaller unsealed arteries could then be seized as soon as exposed, and the operation would probably be completed without serious loss of blood, while the special risks appertaining to the ligature of the larger trunks, and particularly of the common carotid, would be evaded. In cirsoid aneurism of the hand, amputation of the member may be performed should coagulants and other measures fail.

It has been observed that the dilated and tortuous arteries tend to return to their normal condition after the cure or removal of the pulsating tumour. This fact indicates the latter as the starting-point of the disease, but still leaves its intimate pathology open to discussion.

In conclusion may be noticed two measures which have been tried with success, each in one instance—the use of setons after ligature of the supplying vessels (Southam), and circular section of the tissues around the tumour, also after preliminary ligature of the afferent arteries, followed by compression in the line of the incision (Verneuil). William Anderson.

CLAVICLE, Dislocations of the.—The clavicle may be dislocated at its acromial or sternal extremities. The acromial dislocations, which are the most common, will be described as dislocations of the scapula. In spite of the simple arthrodial nature of the clavicular joints, and of the exposed situation of the bone, injuries from falls upon the shoulder commonly result in fractures of the clavicle or in dislocations of the shoulder-joint, and but very rarely in displacement of either extremity of the clavicle from its articulation, as dislocation is prevented by the strong supplementary ligaments of these joints.

The *sternal end* of the clavicle may be dislocated in three directions—*forwards*, *backwards*, and *upwards*. These might be conveniently named the ante-sternal, post-sternal, and supra-sternal dislocations of the clavicle.

The *forward dislocation* (ante-sternal), is usually caused by violence applied to the anterior part of the shoulder, forcing the outer end of the clavicle backwards. In children it may be caused by lifting them by the arm, and Fergusson mentions a case which happened during birth. It may be *partial*, in which case the end of the clavicle projects somewhat beyond its normal level, and may be readily pushed back; or it may be *complete*. In the latter case the displaced bone passes forwards, inwards, and somewhat downwards upon the sternum, where it forms a very distinct projection. It could only be mistaken for a fracture close to the articulation or a separation of the epiphysis. By extending the shoulders, which may be effected by the knee pressed on the spine, aided by pressure on the dislocated bone, the deformity is readily made to disappear, but the difficulty of retaining the bone in position after reduction is very great. The treatment usually adopted is to put the arm up in precisely the same way as for fracture of the clavicle, with the addition of a pad secured by strapping over the sternal end. In the case of a lady it might be worth while to insist on the recumbent position being maintained till firm union had been secured. In any case the arm must be retained in bandages for six weeks or two months. Even then a false joint is a common result; but such a termination gives rise to little impairment of the usefulness of the limb. Hamilton relates a case in which he found it impossible from the first to reduce the dislocation, and the bone was left in the position in which it was found. Putégnat has recorded the case of a girl of seventeen who could voluntarily produce forward dislocation of both clavicles as an amusement. The double luxation had followed a severe fall upon the hands.

Dislocation backwards (post-sternal) may be produced by a fall on the back of the shoulder, forcing the outer part of the clavicle forwards, or by a direct blow upon the inner end of the bone, or by lateral compression of the shoulders. It has also been brought about gradually by extreme curvature of the spine. In order of frequency it stands next to dislocation forwards. The bone is not driven simply backwards, but becomes lodged between the upper edge of the sternum and the trachea, causing dyspnœa, difficulty in swallowing, and pain in the neck—symptoms which the patient endeavours to relieve by bending his head forward, and which are increased by throwing the head back. In a case related by Pellieux, however, these severe symptoms were not present, owing probably to the end of the clavicle not having been caught behind the edge of the sternum. In the position of the prominent end of the clavicle a depression is present, into which the finger may be dipped. The acromion is somewhat nearer the median line, and the clavicle is directed from this point inwards and backwards. In a case dissected by Erichsen, the rhomboid ligament remained unruptured, and had carried away with the clavicle the cartilage of the first rib.

The treatment of backward dislocation has been more successful than when the bone is displaced forwards. The deformity is easily reduced by placing the knee on the spine and drawing the shoulders back. To retain the bone in position, the shoulders should be fixed to a broad splint placed transversely behind the scapulæ. The splint should be thickly padded, or a small pillow may be introduced between it and the spine. The shoulders should be retained in this position for two or three weeks, after which time the splint may be removed, but the movements of the shoulder on the affected side should be restrained for two or three weeks longer.

Dislocation upwards (supra-sternal) is produced by a force acting from above on the point of the shoulder, by which the acromial extremity of the clavicle is driven downwards and inwards. The sternal end is in this way torn from its attachments, and rises between the sternal head of the sterno-mastoid and the sterno-hyoid muscles; at the same time it passes inwards so as to lie above the sternal notch, and may reach. or even pass under, the edge of the sterno-mastoid of the opposite side, as in a case observed by Malgaigne. Bryant describes the case of a young woman seen by him two years after she had been crushed in a crowd, where there was displacement of the inner extremities of both clavicles, which, by pressure upon the shoulders, could be made to touch. R. W. Smith obtained a dissection in one case, and found all the ligaments, including the rhomboid, torn, and the inter-articular fibro-cartilage separated from its sternal attachment.

The symptoms are depression of the shoulder, which approaches nearer the median line, and visible elevation of the sternal extremity of the clavicle. The sternal origin of the sterno-mastoid muscle is pushed forward by the bone, and a depression can be felt at the site of the damaged articulation. The displaced bone encroaches upon, and partially or completely obliterates, the episternal depression. The dislocation is easily reduced by raising the shoulder, and at the same time drawing it back.

For this dislocation the writer is inclined to think Velpeau's suggestion is the best. This surgeon carried the elbow forward so that the hand rested on the sound shoulder, then supported the elbow, and bound the arm to the side by means of a dextrine bandage, which was kept on for fifty days. When the elbow is carried forward, the humerus may be used to push the acromion upwards and backwards, and the writer has found this position of great service in treating dislocation at the acromial extremity of the clavicle.

Simultaneous Dislocation of both ends of the Clavicle.—There are four recorded cases in which at the same time that the sternal extremity of the clavicle was dislocated forwards, the outer end was displaced above the acromion. To treat such a case it is necessary that the shoulders should be drawn well back, and retained in that position whilst a compress is placed over the bone to steady it.

R. Clement Lucas.

CLAVICLE, Fracture of the.—This bone is commonly fractured at all periods up to advanced life; but nearly half the cases are those of children under six. Several instances of intra-uterine fracture of this bone by external violence are on record. The fracture may be transverse, or very oblique; incomplete (greenstick), multiple, or comminuted; it is very rarely compound. The break is most commonly situated at the outer part of the middle third, where the bone is small, and where the two curves meet, but any part may give way. Owing to the absence of displacement and of crepitus, incomplete fracture is apt to be overlooked. When displacement occurs, the sternal fragment is more or less tilted up by the sterno-mastoid, and the acromial end is carried downwards and inwards by the weight of the arm and the action of the surrounding muscles. The sternal end thus overrides the acromial. This position is, very occasionally, reversed. The sternal end, when short, has been seen nearly erect. Occasionally both clavicles are broken.

Symptoms.—The shoulder drops inwards, downwards, and forwards, so as to contrast strongly with the opposite side, with which it should always be carefully compared. The patient leans over to the injured side, and often supports the elbow with the other hand. Deformity of the bone can be felt, and often seen. Swelling over the fracture is often well-marked. Crepitus is felt, if not before, by raising and drawing back the shoulder so that the fragments are brought into contact; there is acute pain at the seat of fracture, especially on movement; rarely ecchymosis. In children displacement is usually slight, and the only signs are pain, swelling, and a momentary 'click' on movement. At the sternal end fracture produces slight displacement; at the acromial end considerable; in fracture between the conoid and trapezoid ligaments displacement is very slight, or entirely absent. The vessels and brachial plexus generally escape injury; but cases of rupture of the artery, and others of the subclavian or internal jugular vein, and many of paralysis of the arm from injury to the brachial plexus, have been recorded. Paralysis may be caused by ill-applied pads and compresses. Failure of union is very rare. The functions of the arm are regained, even though deformity is considerable.

Treatment.—It is often difficult or impossible by any apparatus to keep the fragments exactly adjusted. Deformity and bony swelling are most securely prevented by keeping the patient in the horizontal posture, with the shoulders resting on a flat mattress, for a fortnight or three weeks, but few care to submit to this treatment. The old figure-of-8 bandage has been generally discarded. Many complicated appliances have been proposed as substitutes, but simple means are the most efficient. A wedge-shaped pad may be placed base upwards in the axilla, the elbow drawn a little backward on the chest, and it and the forearm be raised and supported by a sling passed over the opposite shoulder. The arm should then be securely, but not tightly, bandaged to the side. The bandages should be sewn together here and there, or brushed over with starch, to fix them. Ellis's apparatus, consisting of a crutch-pad, sling, and strap for the arm, conveniently carries out this plan; or Sayre's method, which seems at present to be generally popular, may be used:—'Two strips of plaster, spread on moleskin or strong calico, are cut, each three and a half inches wide for an adult: one long enough to encircle first the arm and then the body completely; the other to reach from the sound shoulder over the elbow of the broken limb, and across the back obliquely to the point of starting. The first piece is looped around the arm just below the axillary margin, loosely enough to avoid constriction, and the loop is strongly sewn. The arm is then drawn downwards and backwards, so that the pectoralis major is put on the stretch, and the long end of the strapping is then carried completely round the body, and is stretched to itself on the back. The second strip is then applied, commencing on the front of the shoulder of the sound side, is thence carried over the top of the shoulder, diagonally across the back, under the elbow, diagonally across the front of the chest to the point of starting, where its ends are securely sewn together. A longitudinal slit is made in the plaster to receive the point of the elbow. Before laying the plaster across the elbow, an assistant must press the elbow well forwards and inwards, and it must be held firmly in this position until the dressing is completed. It will now be seen that the arm has been converted into a lever, whose fulcrum is the loop of plaster at the lower margin of the axilla, and upon this it is believed that, in a great measure, the efficiency of the apparatus depends.' Hamilton does not favour this method, nor can the present writer. He agrees with Hamilton that, when all has been said, some simple appliance, consisting of a sling, an axillary pad, and a bandage to keep the arm to the side, is still the best that can be used. Union is generally complete in children in about three weeks; in adults in from a month to five weeks. Should stiffness of the shoulder-joint remain, the limb should be gently moved through its full range when the patient is under the influence of an anæsthetic. For this purpose nitrous oxide gas is generally quite sufficient. In comminuted fractures, should there be evidence that the vessels are pressed upon, the patient should be confined to the horizontal position, with the arm slightly drawn away from the side. Howard Marsh.

CLAVUS. *See* Corns.

CLEFT PALATE, The Mechanical Treatment of.—The successful treatment of a cleft palate by a mechanical appliance is dependent upon a clear recognition of the conditions that are essential in the treatment of all cases of cleft palate, whether the method be surgical or mechanical.

These conditions are :—

(1) The restoration of continuity of surface in the palatine arch.

(2) Separation of the arch of the palate from the floor of the nose.

(3) The possibility of cutting off communication between the mouth and the naso-pharyngeal cavities, at the will of the patient, by contact between the edge of the free border of the palate and the posterior wall of the pharynx, irrespectively of the nature of the means by which the *velum palati* has been restored.

It does not come within the scope of the present article to indicate how far these conditions may or may not be fulfilled by the operation of staphyloraphy. It is only necessary to indicate the nature of the various appliances that have been invented and used for the treatment of congenital fissure, dealing, however, only with those that possess some element of utility combined with novelty.

It is unnecessary to enter into the details by which an impression is obtained of the mouth with its fissured soft palate, soft and hard palate, or even fissured soft and hard palate and alveolar arch. Whether the cleft be limited to the uvula, or pass through to the front of the mouth and be combined with single or double hare-lip, is a matter of but little moment for our purpose. It simply resolves both deformity and treatment into a question of degree, and does not affect the principles involved in treatment.

Starting with the assumption that a perfect model of the mouth has been obtained, three methods of dealing with the case present themselves for consideration.

We will discuss the simplest way first. This consists in adapting a gold, platinum, or thin vulcanite plate to the front part of the mouth, filling up all gaps in the dental arch with artificial teeth, and covering over any portion of the fissure that may exist in the hard palate, and restoring it to symmetry of form and relative smoothness of surface. Such a plate is held in position by bands passing round the natural teeth, and, as a rule, covers the whole of the anterior part of the mouth and passes backwards nearly to the boundary of the normal hard palate. Attached to the posterior margin of the plate by means of studs, screws, stitches, or clamps, we have an artificial *velum palati*, made of elastic rubber, either moulded expressly for the particular case or cut out of a sheet of elastic varying in thickness according to the size of the cleft and the age of the patient; thus, for a child under ten years of age, 2 millimetres thick would be sufficient, whilst for an adult it may be 3 millimetres or even 4 millimetres with advantage. The elastic flap must extend back to such an extent that, by the upward pressure of the tongue, the artificial velum will be brought into absolute contact with the posterior wall of the pharynx.

Here it will be seen that we fulfil most of the conditions that have been laid down as essential to successful treatment by mechanical means. We have simplicity of construction, and an appliance that can be worn with relatively little trouble; but against this we have an elastic velum that, from its nature, must of course be perishable and apt to break down in texture, and become offensive in odour if not kept very clean and frequently renewed. It must be further observed that the whole appliance is very much of the nature of a valve covering an opening, and is not in any sense a plug or obturator in relation to the lateral boundaries or walls of the cleft. It will also be seen that the elastic velum, attached at one margin only, does not in any way represent the tense, resonant surface of the normal soft palate. The cases treated by this method have, however, given exceedingly satisfactory results in many instances, and the name of the late Mr. Edwin Sercombe, who did much to make it popular, should always be remembered in connection with this form of artificial palate.

Following on the lines of Stearn (an English surgeon who wrote about 1845), Dr. Kingsley, of New York, introduced, in 1864, a very perfectly constructed form of elastic velum which at once fulfilled nearly all the conditions that the writer has already stated to be essential. The Kingsley velum was, roughly speaking, of the nature of a stud, and, if we think of the fissure as like a button-hole torn open at one end, it will be easier to understand how the stud passed through the open end of the button-hole and, by being kept forward at the perfect end of the button-hole, became self-supporting; in other words, there was a flap to reproduce the floor of the nares, a flap to restore the palatine arch, and the two flaps were held together by a stem that was fitted to the margins of the cleft. All this being in one, and made of elastic rubber vulcanised in metal moulds, a very beautiful appliance was produced; and when fixed in the mouth by attachment to a gold plate fitting the lingual aspect of the teeth, the elastic velum moved up and down with the muscular movements of the divided soft palate, and could be brought into contact with the posterior wall of the pharynx. The earlier instruments made by Kingsley have not been described, as they were wrong in certain details and unnecessarily difficult to make, and, from their extreme tenuity, wore out very quickly. The modified Kingsley velum, however, is a most useful invention, and has been applied in a large number of cases by the late Mr. Ramsay and the writer. The only objections to it are its destructibility by the secretions of the mouth and nose, and its want of resonance as compared with other materials. It will be recognised at once that Kingsley's velum is partly of the nature of a valve and partly of the character of an obturator, plugging up the cleft.

The third method of mechanical treatment to be considered is due to the inventive faculty of Dr. Wilhelm Süersen, of Berlin. It consists of an obturator made of hard rubber, the fore part fitting around the teeth and covering the hard palate, and the rest filling up the gap of which the margins of the fissure and the wall of the pharynx are the boundaries. The front portion is of no moment; its use is obvious—namely, to support the part of the instrument that fills up the cleft. The obturator proper, however, is very interesting in form, though commonplace in material and construction. It consists of a pyramid having its base parallel with the posterior wall of the pharynx and its apex towards the anterior point of the cleft. One side of the pyramid is on a plane with the natural palate in so far as it exists, the upper side forming the floor of the nares, and grooved down its centre for the free passage of secretion. The two remaining sides of the pyramid are in contact with the lateral margins of the cleft, but do not fit so closely as to produce any pressure when the palate is in a state of repose; but as, in the process of swallowing and in the utterance of certain sounds, the muscles of the palate are drawn upwards and increased in volume laterally, so pressure is exercised upon the rigid obturator, and perfect occlusion between the mouth and the nose takes place along the margins of the cleft. At the same time, the muscular tissue of the upper and posterior part of the pharynx is thrown into well-marked action, with the effect that the space between the base of the pyramid and the wall of the pharynx is completely blocked up by the increased bulk of the muscles in this position; thus the naso-pharyngeal cavities are separated from the mouth coincidently with the closure of all communication between the nose and the oral cavity.

Such an appliance offers the following advantages over those already described:—It is easily kept clean. It does not undergo any change in texture by use in the mouth. It cannot easily be broken or damaged; and, above all, it produces a far more resonant quality of voice than if an elastic velum be used, and this resonance is still further increased if the lower surface of the palate, with the front portion, be made of gold.

The most perfect appliance will produce, however, the most disappointing results unless the patient be intelligent and painstaking. It must always be borne in mind that the restoration of an organ is not the restoration of a function, but simply a means to that end. Hence, where the work of the dental surgeon leaves off, the skill of the teacher of elocution should begin.

OAKLEY COLES.

CLEFT PALATE, The Surgical Treatment of.—The palate may be congenitally cleft in very varying degrees, from a bifid uvula, which represents the simplest form and the slightest extent of the deformity, to a complete separation of all the structures forming the hard and soft palate.

The soft palate may be cleft to uncertain degrees, but it is rarely completely divided without there being at the same time some want of union of the palate-bones.

The hard palate, consisting as it does of six symmetrical bones, usually presents one of three degrees of non-union in the middle line, viz. either the palatine portions of the palate-bones are alone separated, or with them the palate-plates of the superior maxillary bones are cleft, or, in addition, the intermaxillary bones and alveolar arch are divided.

The failure of union is usually rather to the left side of the middle line; and, in clefts involving the hard palate, the septum nasi is generally united at its lower border with the right maxillary bone; but in some of the worst cases the bony septum of the nose hangs free, at its lower edge, being altogether unconnected with the bony palate. Clefts of the hard palate alone are scarcely ever met with; occasionally the failure in the process of union shows itself in the existence of congenital holes in the middle line of the palate, but these are very rare as a congenital defect, though they may be seen as the result of disease.

Symptoms.—The defect, if combined with hare-lip, is usually sufficiently obvious. In the slighter degrees of cleft-palate there may be no such interference with suction and deglutition as to attract attention; while in some cases the only noticeable symptom is the occasional escape of milk from the nostrils. More frequently the child cannot suck at all; or, if able to suck, it can only swallow a small quantity, the greater part of the milk escaping by the nostrils. Among newly-born infants, in any case of unexplained difficulty in taking food, it is well to examine the condition of the palate.

Treatment.—Since the only inconveniences of cleft-palate in early infancy are connected with suction and deglutition, the only treatment required at this age has for its object to secure a sufficient supply of food. Where a child cannot suck or retain its food, an attempt should be made to give nourishment very slowly, with a small spoon passed far back into the mouth, or, as recommended by Mr. Coles, an ordinary feeding bottle may be used, having a thin leaf-like sheet of india-rubber fixed above the teat, sufficiently large to occlude the cleft in the palate.

In many cases the child can be fed from a bottle with an india-rubber teat big enough to fill the gap in the palate; the teat having a large hole on the under side near its extremity, so that the milk can easily escape. Even in the worst cases children can be fed by using an old-fashioned flat feeding-bottle having a large teat, with a hole in its extremity through which food can be poured into the pharynx at suitable intervals by tilting the bottle.

Age for operative treatment.— The earlier in life the defect is remedied the more satisfactory will be the result as regards the perfection of articulation, and cases have occurred in the writer's experience where, after a successful operation at a very early age, no defect whatever has been noticed when in due time the patient had learned to speak. But the age at which the operation should be performed must vary with the nature and degree of the cleft, and the health and vigour of the patient. Doubtless the deformity can be cured in very early infancy, but regard being had to the difficulty and even danger of the proceeding, and the many possible causes of failure at this period of life, it is prudent to postpone operative treatment.

In the first three or four years of life, clefts of the bony palate generally diminish greatly in width, especially at their anterior extremity, where in the process of growth fissures in the alveolar arch may be observed to close altogether by coalescence of their opposite edges. Thus with the lapse of time the operation becomes less difficult of performance and no longer dangerous.

None but very general rules can be laid down as to the best time for operating, since each case must be judged on its own merits, and every surgeon will be guided chiefly by the results of his own experience. In deciding this question, the difficulty of the operation and the constitutional condition of the patient must be taken into consideration, and in estimating the difficulty of the proceeding, regard must chiefly be had to the width of the cleft in relation to the amount of material available for its closure.

In the case of the soft palate, this may easily be estimated by observing the width and thickness of the sides of the velum; in clefts of the hard palate the pitch of the palatine arch should chiefly be noticed. for the higher the palatine arch the more material will be available for flaps. The union of the septum nasi with one maxillary bone is also a favourable condition, as furnishing on one side at least an abundant flap; the mere length of a cleft adds little or nothing to the difficulty of closure.

In healthy children, clefts involving the velum only, without deficiency of the soft parts, may generally be cured in the third year of life. Fissures which affect the soft palate and more or less of the hard, may, as a rule, be closed before the end of the sixth year, if the cleft be not very wide and there is a sufficiency of material for flaps.

In cases of unusual local difficulty, or where the general health is feeble or there is considerable infirmity of temper, the operation may need to be still longer postponed; but, if the case be curable at all, it is rare that this cannot be accomplished before the patient is twelve years of age. When, from one cause or another, the operation has been long delayed, though a successful union may be more easily obtained, the results as regards articulation will be less satisfactory.

Order of operation.—There is some difference of opinion as to whether the union of the hard and soft palate should be attempted in one operation. The writer believes he has sufficient experience to justify him in recommending that the whole cleft should be closed at one and the same time, unless there are circumstances of peculiar difficulty in the case. When the bringing together of the whole cleft in one operation would necessitate so free a division of the soft parts as to endanger the vitality of the flaps, it is advisable to close first that part of the cleft that can be most easily approximated, whether it be the hard or the soft palate. This, if successful, will secure for the remaining portion a large supply of blood in the subsequent operation.

Instruments.—A cleft-palate case should contain—two sharp-pointed tenotomy knives mounted on long handles, for paring the edges of the cleft; one blunt-ended knife of the same kind, for making lateral incisions to relieve tension; a small rectangular knife (Fergusson's), for tracing a flap, when one has to be brought down from the septum nasi.

Two pairs of long forceps—one mouse-toothed, the other serrated; a fine double hook. A pair of strong sharp-pointed scissors curved to a quarter circle, for dividing the connection of the soft palate with the nasal mucous membrane, at the posterior margin of the hard palate. Two raspatories curved as an aneurism needle; one raspatory very slightly curved. Two needles with eyes at the point mounted on long handles, for horsehair or silk; an instrument for catching these sutures at the eye of the needle.

A tubular needle with reel at the base for passing silver sutures, and a wire twister.

A gag of some kind is essential; it should be strong enough to keep the jaws open, and so arranged as to dilate the orifice of the mouth as much as possible, while it depresses the tongue. As is natural, the writer prefers the gag known by his name, but it may well be that other instruments of a similar kind are quite as useful. Cases are met with where the continued depression of the base of the tongue causes difficulty in breathing; for these the gag invented by Mr. Coleman or Mr. Mason is specially adapted; it leaves the tongue free and occupies but little room in the mouth. If this be used the tongue should be held down by a rectangular spatula.

The needles for passing horsehair or silk should be on long, slender handles; they should be rectangular in their curve, flattened laterally, and having a round eye close behind the point.

The best materials for sutures are well-annealed silver wire and horsehair; the wire for the hard palate, or for any part of the soft palate, anterior to the uvula, where there may be tension, the horsehair for the uvula, and the lower and more flaccid part of the velum. Both the wire and the horsehair should in their size be proportioned to the thickness and consistence of the parts to be brought together, that used for the uvula being thinner than should be employed for the velum itself.

Operation.—The patient having an empty stomach, though being in no want of food, may be conveniently placed in the recumbent position on a narrow table in front of a window, the head, thrown well back, being held on a firm pillow by the assistant who also takes charge of the gag. As a support for the head a small inflatable air-cushion is to be preferred. Two assistants are required besides the administrator of chloroform, one to steady the head and hold the gag, the other to assist in the actual operation. The complete quietude of the patient should be secured by means of a wide strap passed across the thighs and beneath the table; to this strap the hands should be loosely tied.

Operation on the Soft Palate.—The patient being under chloroform the gag should be introduced, the jaws opened, the tongue tucked under the tongue-plate, and the patient's head and gag entrusted to an assistant.

The edges of the cleft may best be pared from below upwards, the point of the uvula being held with the toothed forceps, to render the palate tense. The sponge should be sparingly used, as it tends to produce vomiting, and the flow of saliva increases. Sutures may also be conveniently passed in the same order, and be fastened, if the palate will come together, and cut off, one after another as they are fastened; one suture, the last passed, being always left in the palate, uncut, to be used to draw forward the margins of the cleft, to assist in passing the next suture. The sutures should be passed through both sides of the palate at one transit of the needle, and if the cleft will come together they should be fastened off at once—the horsehair by tying, the wire by twisting.

When there is too much tension to admit of the sutures being tied at once, they should all be passed, and, being loosely twisted, the long ends may be cut off, and longitudinal incisions may be made on either side, parallel to the cleft and just internal to the hamular process, avoiding the immediate neighbourhood of the posterior palatine foramen. It is well to make this incision with a blunt-ended knife, after puncturing the palate with a sharp-pointed knife. Sufficient relaxation being obtained, the remaining sutures should be quickly fastened off by twisting with torsion forceps.

In cases where the cleft involves more or less of the hard palate, when the soft palate has been closed, so far as it can be without undue tension on the sutures, the operation on the hard palate can be at once proceeded with, if there is nothing in the patient's general condition to forbid it.

Operation on the Hard Palate.—If there is sufficient material for closing the palate the mucous edges of the cleft may be pared. If there is any doubt about this, the proceeding must be dispensed with, as involving a waste of flap.

To bring down the muco-periosteum from the bones, a mere puncture should be made down to the bone with a scalpel, midway between the teeth and the margin of the cleft and opposite the middle of the cleft, midway between the anterior angle of the cleft and the posterior margin of the hard palate. Through this puncture the least curved of the raspatories should be thrust between the periosteum and the bone, and be pushed onwards towards the middle line until its point appears in the cleft. At this spot one of the more curved raspatories should be inserted, the instrument first used being withdrawn. The curved raspatory should now be used to separate the muco-periosteum from the bone, and this is best accomplished by to-and-fro movements and by careful traction. The periosteum is easily detached until the posterior margin of the hard palate is reached, where the soft palate is firmly attached by fascia and by its connection with the mucous membrane of the floor of the nose.

Curved scissors should be used to divide this attachment, the palate being drawn forward with a hook to put it on the stretch while the scissors are passed behind it. The scissors may now be used with closed blades, as a raspatory, to draw forward the soft parts at the junction of the hard and soft palate and complete their separation from the bone. When the hard palate is cleft up to the incisor teeth there is often difficulty in completely separating the periosteum at the anterior angle of the fissure. Should this be the case a small rectangular knife can be used to free the soft parts.

The muco-periosteum being completely separated from one side of the palate, the assistant should thrust a sponge into the cleft and press the flap firmly against the bone. This will restrain all hæmorrhage, give an opportunity for cleansing the fauces from blood, and allow of the re-administration of chloroform.

The soft parts being separated from the bone on the opposite side of the cleft in the same manner, the sutures may be passed as in the soft palate, silver wire being used and each suture being twisted up as far as practicable without risk of breaking, and cut short, so as to leave about a sixth of an inch projecting.

Tension should be relieved by prolonging the small incisions made for the introduction of the raspatory, forwards or backwards, as the circumstances of the case may require. The incisions should go quite through the palate, and they are best made with a probe-pointed knife. All slack sutures should now be twisted up with torsion-forceps until the edges of the cleft are in exact apposition.

In bringing together this part of the palate, care must be taken to evert the edges of the cleft with a small double hook in passing and twisting up the sutures; this secures the apposition of the raw surfaces of the flaps, and it is especially necessary when the edges of the cleft have not been pared.

During the course of the operation there will be frequent interruptions, necessary either for giving chloroform or for freeing the fauces from blood. During these periods a sponge should always be kept pressed firmly into the cleft. The forceps should be very sparingly used to the palate in the operation. Bleeding is better restrained by sponge-pressure than by syringing. Forceps are the best sponge-holders; with them sponges can be seized or dropped in an instant.

In cases where the material for closing the cleft is scanty, a flap must be brought down from the septum nasi, and this can always be done when the septum, as is usually the case, is united with one of the maxillary bones. This flap should be traced out on the septum with a small rectangular knife, and brought down with a sharply curved raspatory.

After-treatment.—No food should be given until two or three hours after the operation, or until vomiting has ceased; for the first twelve hours, cold milk, or milk and water, will suffice, and after this time the patient can be fed on lightly boiled eggs, soft bread and milk, rice-milk, cream, custard, stewed fruits, arrowroot, beef-tea, pounded meats, porridge with milk, &c. These, or such as these, may form the chief articles of diet for a fortnight. It is desirable, but not always possible, in the case of children and delicate young persons, to keep them in bed for a week. Sutures of wire or horsehair may be left in for three weeks or much longer; they should not be removed until after a fortnight from the time of the operation. The palate, in young children especially, had better not be inspected during the first week.

The writer has never met with dangerous, or even severe, hæmorrhage after the operation; but should such occur, and ordinary means fail to arrest it, pressure on or in the posterior palatine canal of the bleeding side would almost certainly put a stop to the bleeding.

It is well to recognise that the cure of a cleft palate does not cure the defect in articulation; it does, however, allow of the patient being taught, or of his teaching himself, to speak with more or less distinctness. The perfection of the result in this respect depends mostly on the care taken to correct defects in articulation by systematic instruction; much also depends on the irregularity, or otherwise, of the dental arch, and the stiffness or pliability of the new velum. M. Trélat insists on the advisability of systematic teaching preceding the closure of the palate, and with this object he postpones the performance of the operation until a later date than is advised by many surgeons. He fixes seven years as the minimum age at which the cure should be undertaken, considering that at an earlier date the operation is dangerous, compromising, or useless. Thomas Smith.

CLINE'S SIDE SPLINTS are adapted to the shape of the leg and foot. They are usually sold in couples, the inner of which is not provided with a footpiece, possibly with the object of allowing inversion of the foot, when used for Pott's fracture. Splints similar to these, but each having a footpiece, are known as either Cline's, Pott's, or Bell's splints. Bilton Pollard.

CLITORIS. *See* Vulva.

CLONIC SPASM.—A condition of general spasm with distinct remissions. *See* Hydrophobia.

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CLOVE-HITCH, a tie which has the advantage of maintaining a firm hold on the limb to which it is applied without becoming tighter, so long as both ends of the bandage or cord are pulled equally. It is used in reducing dislocations, and is most readily made by forming two simple loops in a jack-towel or bandage, and passing the second loop under that first made.

CLUB-FOOT or TALIPES signifies any deformity of the foot caused by an unnatural contraction of muscle, tendon, fascia, or ligament. The varieties of club-foot are: (1) *Talipes equinus*, in which the heel is raised and cannot be brought to the ground, and the patient walks on the toes and the distal ends of the metatarsal bones. (2) *Talipes calcaneus*, the reverse of the last-named variety, in which the heel is depressed and the toes are raised, so that the patient walks on the former. (3) *Talipes varus*, in which the inner edge of the foot is drawn upwards, and the anterior two-thirds of the foot are twisted inwards, the outer edge resting on the ground. (4) *Talipes valgus*, the reverse of talipes varus, in which the outer edge of the foot is drawn upwards, so that the patient rests on the inside of his foot and inner ankle.

These forms are also found in combination, viz.: (1) *Talipes equino-varus.* (2) *Talipes equino-valgus.* (3) *Talipes calcaneo-varus.* (4) *Talipes calcaneo-valgus.*

Talipes may be either congenital, or may come on after birth. The cause of the congenital variety is very obscure. The writer believes it to be due to disordered nervous function acting on the muscles, which draw the foot into its deformed position; and this opinion is confirmed by the occurrence of talipes in cases of spina bifida.

Non-congenital talipes is due to various causes, chief amongst which are: Paralysis, spasmodic contraction of muscles, rupture of tendon or muscle, and the cicatrices following burns and other lesions.

Although space will not allow the pathology of club-foot to be fully considered, it may be mentioned that, in addition to the contracted condition of muscle and fascia, the bones of the tarsus, especially in congenital cases, will be found slightly altered in shape and size, and displaced from their proper positions.

Varieties of Club-foot.—Talipes Equinus (in which the heel is raised and cannot be brought to the ground, and the patient walks on the toes). This form of talipes is hardly ever congenital. On